GE
Measurement & Control Solutions

Gas Analysis

FGA 300H(X)

Horizontal Flue Gas Analyzer

User's Manual

imagination at work

910-078 Rev. E
August 2011

FGA 300H(X)

Horizontal Flue Gas Analyzer

User's Manual

910-078 Rev. E
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Information Paragraphs

- **Note** paragraphs provide information that provides a deeper understanding of the situation, but is not essential to the proper completion of the instructions.
- **Important** paragraphs provide information that emphasizes instructions that are essential to proper setup of the equipment. Failure to follow these instructions carefully may cause unreliable performance.
- **Caution!** paragraphs provide information that alerts the operator to a hazardous situation that can cause damage to property or equipment.
- **Warning!** paragraphs provide information that alerts the operator to a hazardous situation that can cause injury to personnel. Cautionary information is also included, when applicable.

Safety Issues

WARNING! It is the responsibility of the user to make sure all local, county, state and national codes, regulations, rules and laws related to safety and safe operating conditions are met for each installation.

Auxiliary Equipment

Local Safety Standards

The user must make sure that he operates all auxiliary equipment in accordance with local codes, standards, regulations, or laws applicable to safety.

Working Area

WARNING! Auxiliary equipment may have both manual and automatic modes of operation. As equipment can move suddenly and without warning, do not enter the work cell of this equipment during automatic operation, and do not enter the work envelope of this equipment during manual operation. If you do, serious injury can result.

WARNING! Make sure that power to the auxiliary equipment is turned OFF and locked out before you perform maintenance procedures on the equipment.

Qualification of Personnel

Make sure that all personnel have manufacturer-approved training applicable to the auxiliary equipment.

Personal Safety Equipment

Make sure that operators and maintenance personnel have all safety equipment applicable to the auxiliary equipment. Examples include safety glasses, protective headgear, safety shoes, etc.

Unauthorized Operation

Make sure that unauthorized personnel cannot gain access to the operation of the equipment.

Environmental Compliance

Waste Electrical and Electronic Equipment (WEEE) Directive

GE Measurement & Control Solutions is an active participant in Europe's *Waste Electrical and Electronic Equipment* (WEEE) take-back initiative, directive 2002/96/EC.

The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way.

The crossed-out wheeled bin symbol invites you to use those systems.

If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Visit **http://www.ge-mcs.com/en/about-us/environmental-health-and-safety/1741-weee-req.html** for take-back instructions and more information about this initiative.

Chapter 1. General Information

1.1 Overview. . . . 1
1.2 Display Console . . . 5
1.3 Principles of Operation. . . . 6
1.3.1 The Zirconia Oxygen Sensor . . . 6
1.3.2 Platinum-Catalyst Combustibles Detector . . . 8

Chapter 2. Installation

2.1 Overview. . . . 9
2.2 Configuration Options . . . 10
2.2.1 Standard (Weatherproof) Enclosure . . . 10
2.2.2 Sample System . . . 11
2.2.3 Remote FTC Box. . . . 12
2.2.4 Explosion-Proof (Flameproof) Enclosure . . . 13
2.2.5 NPT Probe . . . 14
2.2.6 Installation Pipe . . . 15
2.2.7 Operation Voltages. . . . 16
2.3 Installation Site. . . . 17
2.3.1 Selecting the Site. . . . 17
2.3.2 Preparing the Site . . . 17
2.4 Installing the Probe and Probe Sleeve . . . 19
2.5 Installing the System . . . 20
2.5.1 Mounting the Analyzer. . . . 22
2.5.2 Mounting the Remote FTC Box . . . 23
2.5.3 Mounting the Display Electronics Console . . . 23
2.5.4 Making Wiring Connections. . . . 24
2.5.5 Wiring a 300H(X) with Local FTC. . . . 26
2.5.6 Wiring a 300H(X) with Remote FTC . . . 28
2.5.7 Connecting Recorders . . . 33
2.5.8 Connecting Alarms . . . 33
2.6 Installing Additional Components . . . 37

Chapter 3. Operation

3.1 Overview. . . . 39
3.2 Preventing Common Problems . . . 39
3.3 Powering Up the System. . . . 40
3.4 Taking Measurements . . . 40
3.5 Using the Display and Keypad. . . . 41

Chapter 4. Calibration

4.1 Overview 43
4.2 Recommended Calibration Gases 43
4.3 Calibrating the Oxygen Sensor 45
4.3.1 Regulating the Calibration Gas Flow 45
4.3.2 Calibration Check 47
4.4 Calibrating the Combustibles Detector 50
4.4.1 Checking the Operating Temperature 50
4.4.2 Zero Check 52
4.4.3 Span Check 52

Chapter 5. Troubleshooting

5.1 Overview 53
5.2 Oxygen Errors 55
5.2.1 Blinking “--.--” 55
5.2.2 “PP.PP” and Normal Reading Alternate 65
5.2.3 Blinking Reading 65
5.2.4 Oxygen Concentration Reads Constant 20.9% 67
5.2.5 Oxygen Reading Above 20.9% 69
5.2.6 Oxygen Reading Too Low 69
5.2.7 Oxygen Reading Too High 70
5.3 Combustibles Errors 71
5.3.1 “1 0” Out-Of-Range Indicator 71
5.3.2 “–12340” Negative Reading 72
5.3.3 “-1 0” Negative Out-Of-Range Indicator 73
5.3.4 Low Combustibles Reading, but Correct Oxygen Reading 74
5.4 Calibration Responses 75
5.4.1 Everything Is Fine 75
5.4.2 Forced Flow Problem 75
5.4.3 Dead Space Problem 75

Chapter 6. Parts Replacement

6.1 Overview. 77
6.2 Main Analyzer Unit 78
6.2.1 Removing the Cover 78
6.2.2 Replacing the Oxygen Sensor Clips 79
6.2.3 Replacing the Oxygen Sensor 81
6.2.4 Replacing the Combustibles Detector 84
6.2.5 Replacing the Temperature Sensor 87
6.2.6 Moving the Front Panel Assembly 89
6.2.7 Replacing the Sensor Furnace 90
6.2.8 Replacing the Cartridge Heaters 95
6.2.9 Replacing the Thermostat 97
6.3 FTC Board. 99
6.3.1 Replacing a Local FTC Fuse 99
6.3.2 Replacing a Local FTC Board 101
6.3.3 Replacing a Remote FTC Board Fuse 102
6.3.4 Replacing a Remote FTC Board 103
6.4 Display Electronics Console 105
6.4.1 Replacing the Display Board Fuse 105
6.5 Spare Parts 106

Chapter 7. Specifications

7.1 General Specifications 109
7.2 Oxygen Specifications 110
7.3 Combustibles Specifications 110
7.4 Available Options 111
7.5 Ordering Information 112

Appendix A. Rotary Switch Settings

A.1 Overview. 117
A.2 Selecting the Display Parameter 118
A.3 Selecting the Fuel Type 118
A.4 Adjusting the Oxygen Channel 119
A.5 Adjusting the Combustibles Channel 121
A.5.1 Setting the Scale Type 121
A.5.2 Setting the Zero and Full Scale Values 121

Appendix B. Outline and Mounting Dimensions

Appendix C. The Nernst Equation

C.1 Overview. 137
C.2 Equilibrium Conditions 137
C.3 The FGA 300H(X) Equations 138

Appendix D. Wiring Diagrams and Circuit Boards

Appendix E. Default Settings

E.1 Overview 145
E.2 EMC Compliance 145
E.3 LVD Compliance 145

Appendix F. Previous Configurations

F.1 Overview 147
F.2 Testing the FTC Board and Transformer 148
F.3 Replacing the FTC Board Fuse 150
F.4 Replacing the FTC Board 151
F.5 Replacing a Local Transformer 152
F.6 Replacing a Remote Transformer 154
F.7 Adjusting the Sensor Furnace Temperature 155
F.8 Previous Wiring Diagrams and Circuit Boards 155

Chapter 1. General Information

1.1 Overview

Process plant managers are usually looking for ways to reduce expense and increase profitability. When combustibles are burned as part of the operation, and that combustion is incomplete (allowing unburned fuel to escape), costs go up and profits go down.

A reliable system for analyzing flue gas can provide the necessary information to:

- adjust the flow of oxygen,
- increase the efficiency of the combustion, and
- result in huge cost savings for the overall operation.

To meet these specific needs, GE provides the *FGA 300H(X) Horizontal Flue Gas Analyzer* which monitors the efficiency of a furnace or boiler by measuring excess oxygen and/or ppm_v unburned combustibles in the flue gases.

To measure these two parameters, the FGA 300H(X) uses:

- a zirconium oxide (zirconia) *oxygen* sensor
- a platinum-catalyst *combustibles* detector

The oxygen sensor measures excess oxygen or, in a fuel rich environment, equivalent combustibles. The combustibles detector monitors partially combusted fuel, only in the presence of excess oxygen (i.e. there must be enough oxygen present to burn the fuel). Each FGA 300H(X) may be equipped with an oxygen sensor, a combustibles detector, or both.

The FGA 300H(X) Horizontal Flue Gas Analyzer is available in both the *standard (weatherproof) FGA 300H* and the optional *explosion-proof (flameproof) FGA 300HX*. Physically, the FGA 300H(X) standard and explosion-proof versions look very different from each other. However, the internal components and operation are the same for both versions. See Figure 1 on page 2 for illustrations of the standard and explosion-proof models of the main analyzer unit.

Both versions of the FGA 300H(X) include at least a *Main Analyzer Unit*, which consists of the larger *Sample System Compartment* and the smaller *Accessory Box*. In addition, a remote *Furnace Temperature Control (FTC) Box* and/or a *Display Electronics Console* may be included in the system.

1.1 Overview (cont.)

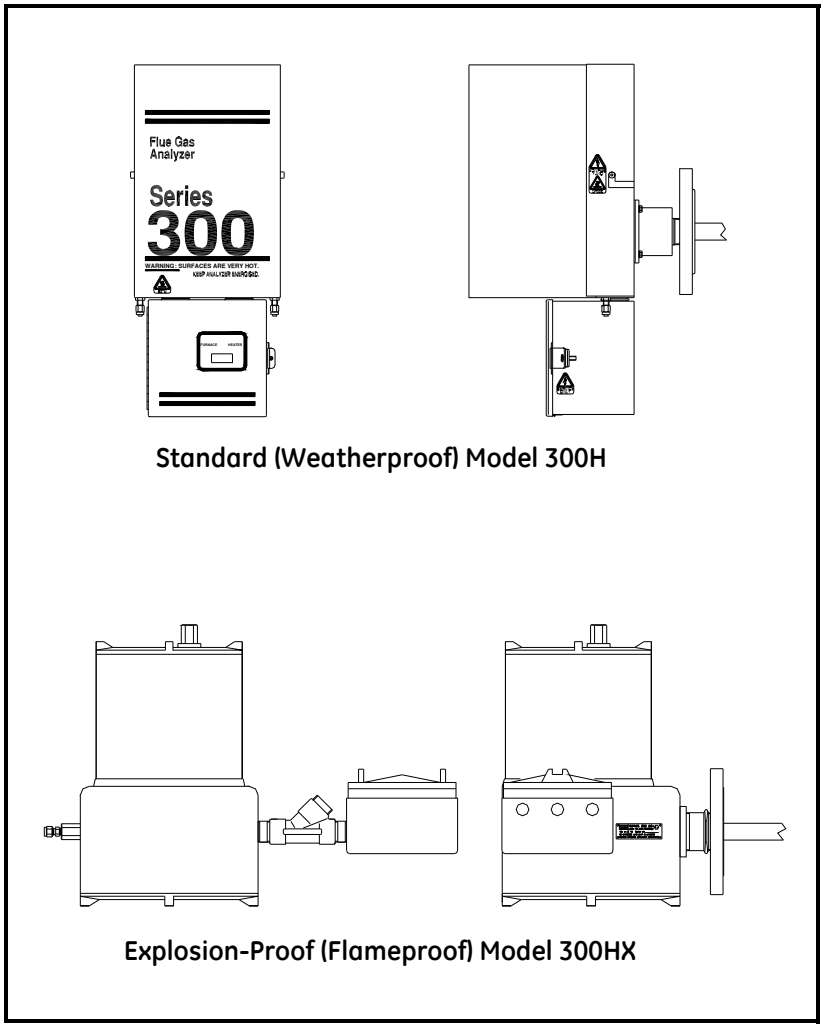

Figure 1: The Main Analyzer Unit

The Sample System Compartment houses the *sample system*, which consists of the components shown in Figure 2 on page 3. The functions of the sample system components are as follows:

- a *heater block* with removable *thermostat* and *cartridge heaters* to prevent acid components of the flue gas from condensing in the sample system and causing corrosion
- a zirconium oxide (zirconia) *oxygen sensor*
- a platinum-catalyst *combustibles detector* to monitor incomplete combustion of the fuel by burning it in the presence of excess oxygen

1.1 Overview (cont.)

- a temperature-controlled *sensor furnace* to maintain the oxygen sensor at a stable operating temperature and to act as the engine for convective sampling
- a *convection loop* to circulate the sample gases through the sample system

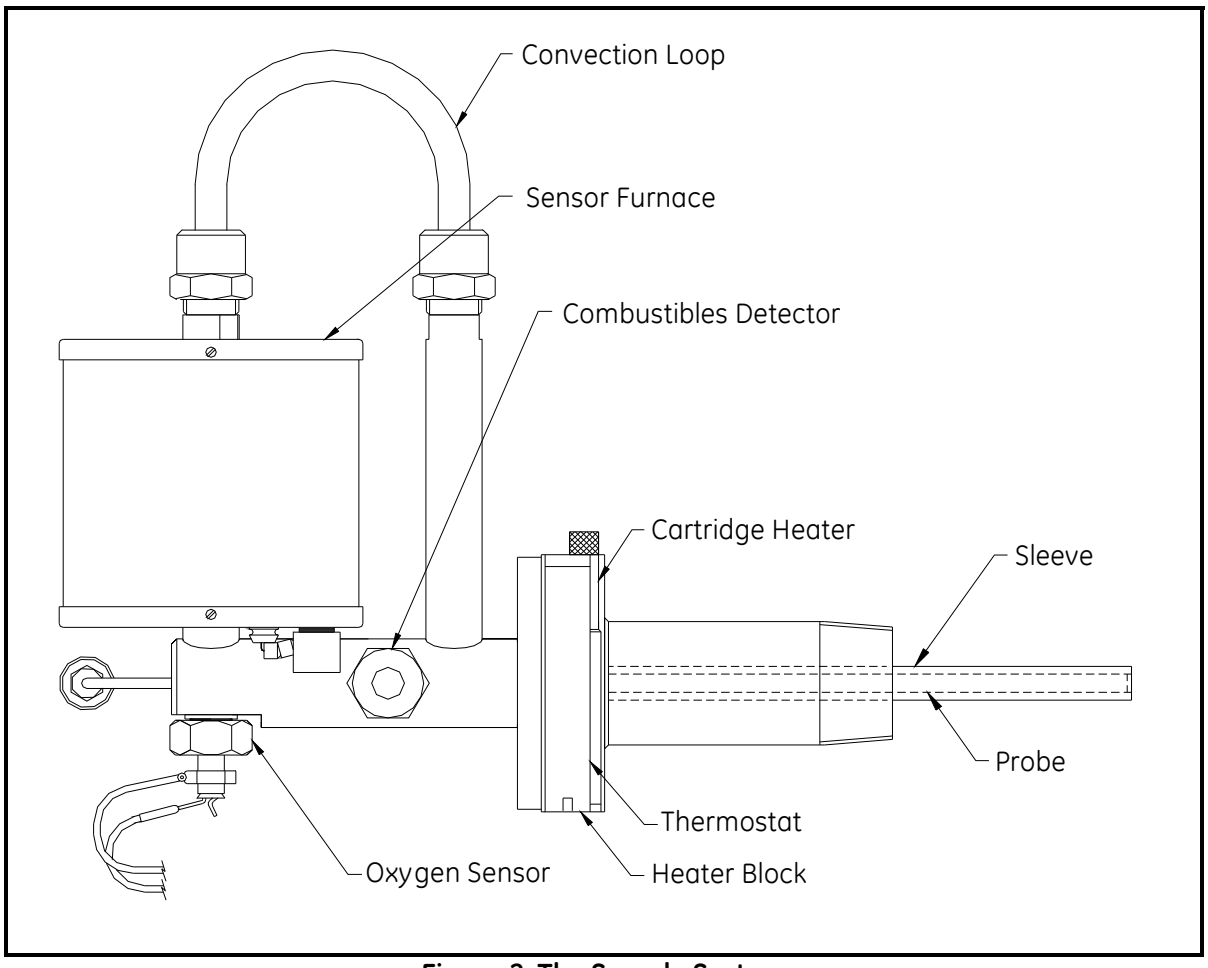

Figure 2: The Sample System

The Accessory Box, which is attached to the Sample System Compartment, contains the *terminal blocks* for making power, sensor output and temperature control electrical connections. In addition, for a standard (weatherproof) system operating in an ambient temperature of -25 to 70°C (-15 to 160°F), a *furnace temperature control (FTC) circuit board* is located in the attached accessory box. However, for an explosion-proof (flameproof) system or a standard (weatherproof) system operating at an ambient temperature in excess of 70°C (160°F), the furnace temperature control (FTC) board is located in a remote *Furnace Temperature Control (FTC) Box*.

1.1 Overview (cont.)

The furnace temperature control (FTC) board maintains a constant sensor furnace temperature. This temperature stability improves the accuracy of oxygen analysis and extends the life of the oxygen sensor. Locate a remote FTC Box as close to the Main Analyzer Unit as possible, as long as the ambient temperature at the chosen location is -25 to 70°C (-15 to 160°F). The remote FTC Box may be ordered as either a standard (weatherproof) model or an explosion-proof (flameproof) model, as shown in Figure 3.

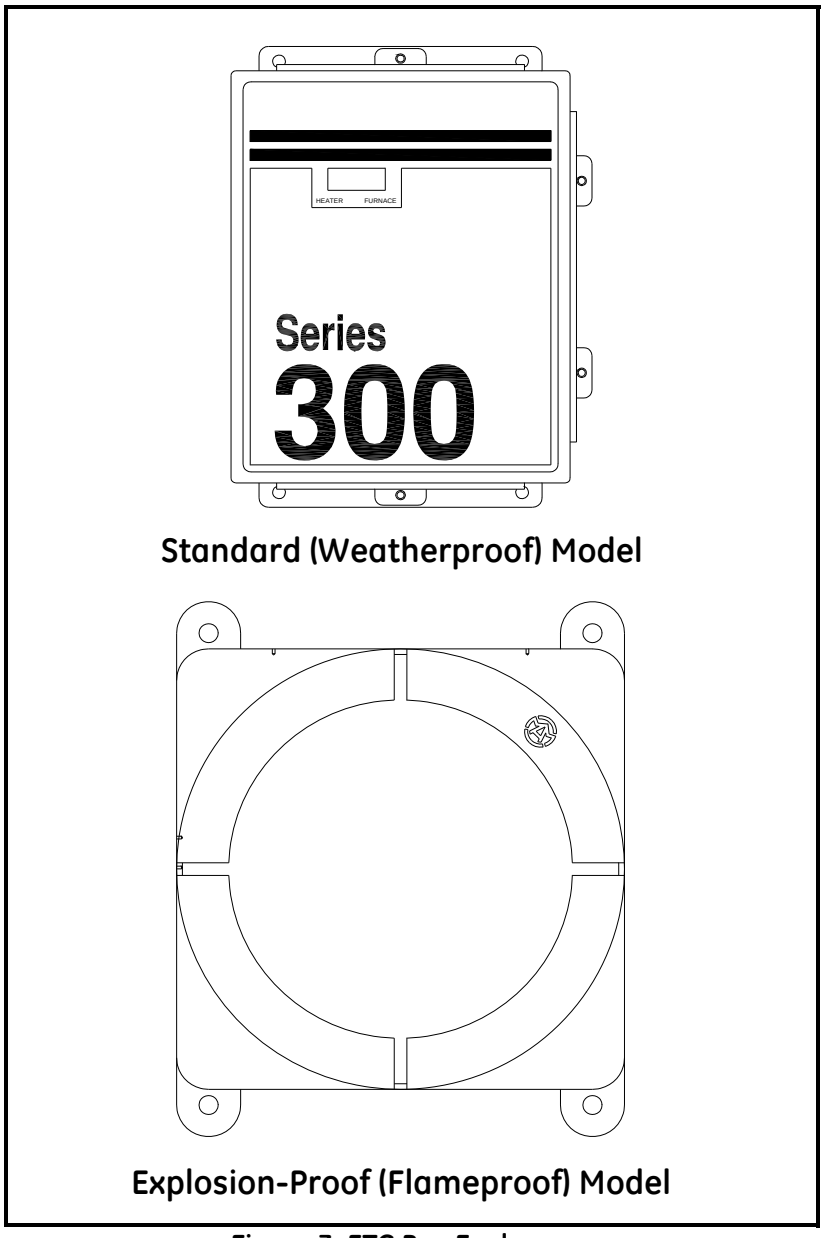

Figure 3: FTC Box Enclosures

1.2 Display Console

The 300D *Display Electronics Console* is available for use with the FGA 300H(X). The Display Console can display a variety of system parameters. Figure 4 shows a Display Console with both oxygen and combustibles outputs.

Note: *A Display Console is required for any FGA 300H(X) equipped with a combustibles detector.*

The Display Console performs the following functions:

- amplifies the oxygen sensor and combustibles detector outputs
- linearizes the oxygen signal
- shows percent oxygen on a four digit LED display
- shows ppm_V combustibles on a 4 1/2 digit LED display
- provides a stoichiometric interlock (optional)

Note: *This device triggers an alarm if the excess oxygen level drops below 100 ppm_v or the combustibles exceeds 20,000 ppm_v.*

- provides an indication of oxygen sensor resistance
- provides an indication of convection loop plugging/blockages
- provides an indication of oxygen sensor aging.

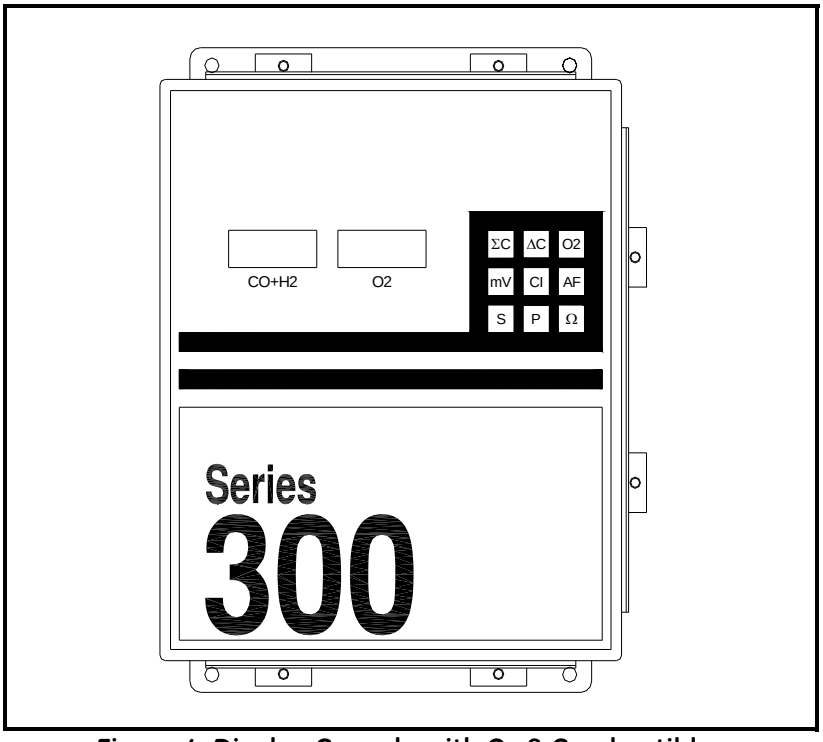

Figure 4: Display Console with O_2 & Combustibles

1.3 Principles of Operation

Ideally, every furnace/burner should mix a precise ratio of air to fuel, and the mixture should burn efficiently to yield only heat, water vapor and carbon dioxide. However, because of burner aging, imperfect air to fuel mixtures and changing firing rates, this rarely happens. Monitoring the actual efficiency of the combustion process is easily accomplished with the FGA 300H(X).

A flue gas sample is drawn into the probe by gaseous diffusion and a gentle convective flow. The sample passes through the probe and into the sample system, where it is maintained at a temperature above 200°C (392°F) by the heater block. In the presence of oxygen, this sample temperature is high enough to burn any partial combustion products that reach the active (platinum-coated) element of the combustibles detector. The resulting temperature differential between the two combustibles detector elements is related to the concentration of partial combustion products in the test sample.

Note: *The sampled gas is maintained above 200°C (392°F) to prevent flue gas acids from condensing in the analyzer and causing corrosion.*

The sample then passes into the sensor furnace, which heats the sample gas and the oxygen sensor to 700°C (1,292°F) (a temperature above 650°C (1,202°F) is required for proper operation of the oxygen sensor). The oxygen sensor is covered with a platinum catalyst that burns all remaining combustibles, enabling the sensor to measure the excess oxygen (or fuel) in the flue gas.

The sensor furnace also generates the convective flow that circulates the sample gas through the sample system. The hot sample gas in the sensor furnace rises out of the furnace and cools, as it is pushed from behind by the hot gases still in the furnace. The cooled sample gases then drop down the other branch of the convection loop and into the annular space between the probe and probe sleeve, where they are carried away by the gas flow in the flue.

1.3.1 The Zirconia Oxygen Sensor

The inside and outside of the zirconia oxygen sensor (see Figure 5) are coated with porous platinum, forming two electrodes. The sample gas flows past the outside of the sensor, while atmospheric air circulates freely on the inside of the sensor. This atmospheric air is used as the reference gas for making oxygen measurements. See Figure 6 on page 7.

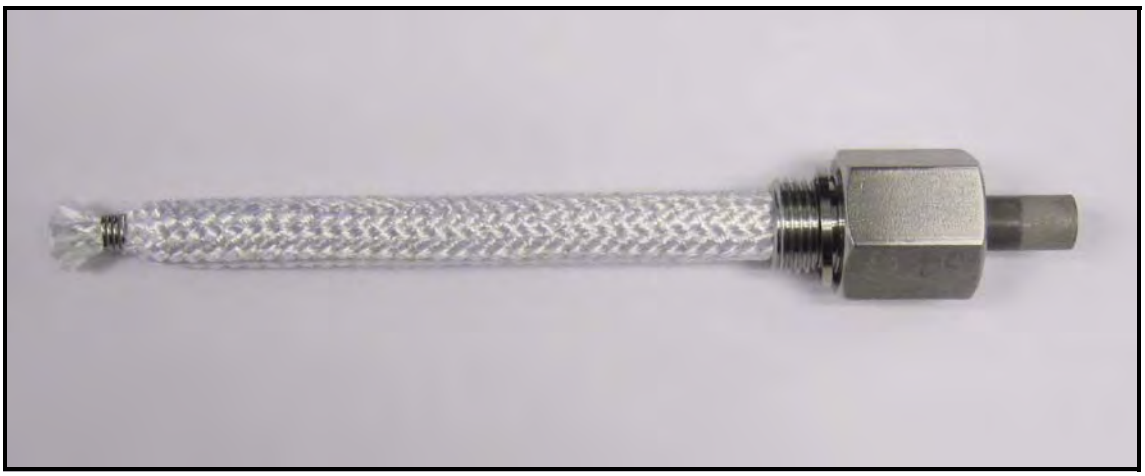

Figure 5: Zirconia Oxygen Sensor

1.3.1 The Zirconia Oxygen Sensor (cont.)

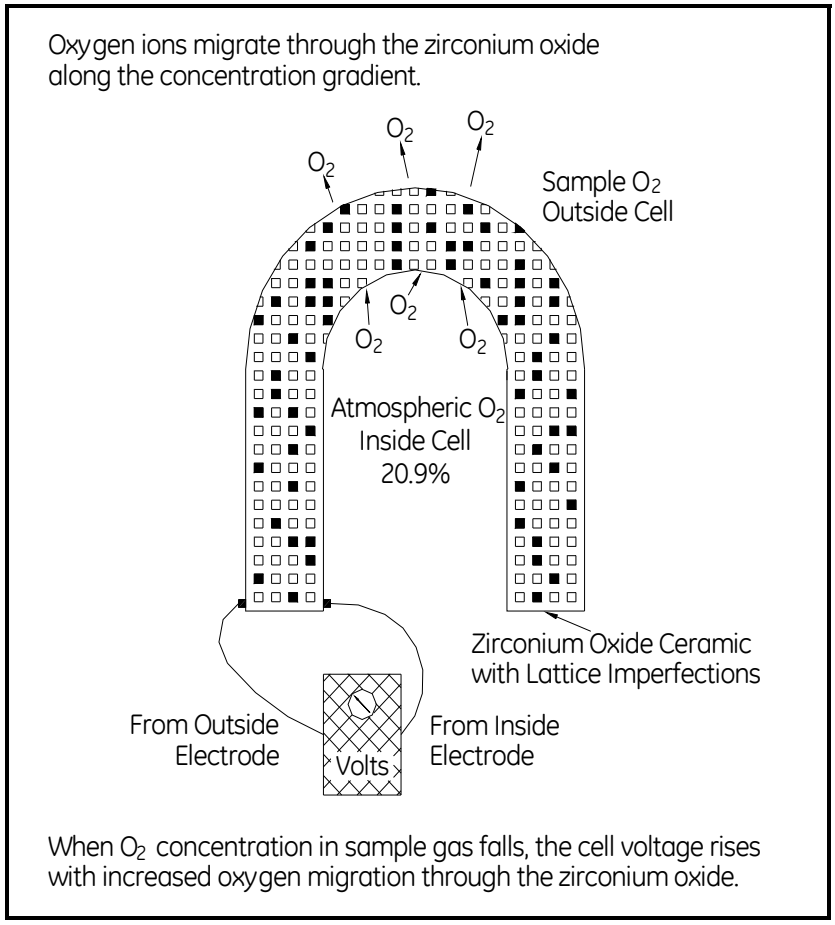
Oxygen ions migrate through the zirconium oxide along the concentration gradient.
O_2
O_2
O_2
Sample O_2 Outside Cell
O_2
O_2
O_2
Atmospheric O_2 Inside Cell 20.9%
Zirconium Oxide Ceramic with Lattice Imperfections
From Outside Electrode
From Inside Electrode
Volts
When O_2 concentration in sample gas falls, the cell voltage rises with increased oxygen migration through the zirconium oxide.

Figure 6: Oxygen Migration in the Zirconia Sensor

At the operating temperature of the oxygen sensor, the atmospheric reference oxygen is electrochemically reduced at the inner electrode, and the resulting oxygen ions seek to equalize with the lower oxygen concentration on the sample side of the cell by migrating through the porous ceramic toward the outer electrode. At the outer electrode they give up electrons to become oxygen molecules again, and are swept away by the sample gas flow.

The lower the concentration of oxygen in the flue gas sample, the greater the rate of ion migration through the ceramic, and the higher the cell voltage due to electron exchange at the electrodes. The cell voltage rises logarithmically as the amount of oxygen in the flue gas falls, allowing the accurate measurement of very low levels of excess oxygen in the flue gas.

1.3.2 Platinum-Catalyst Combustibles Detector

The combustibles detector consists of two platinum thermistors mounted side by side in the sample stream. One thermistor, the *active element*, is used to detect/react partial combustion products, while the other thermistor, the *reference element*, provides a baseline. The active element is coated with a black platinum catalyst and the reference element has a white inert surface. As the sample gas passes over the active element, the platinum catalyst causes any combustibles to burn (in the presence of excess oxygen), thereby raising the temperature of the active element above that of the reference element. See Figure 7.

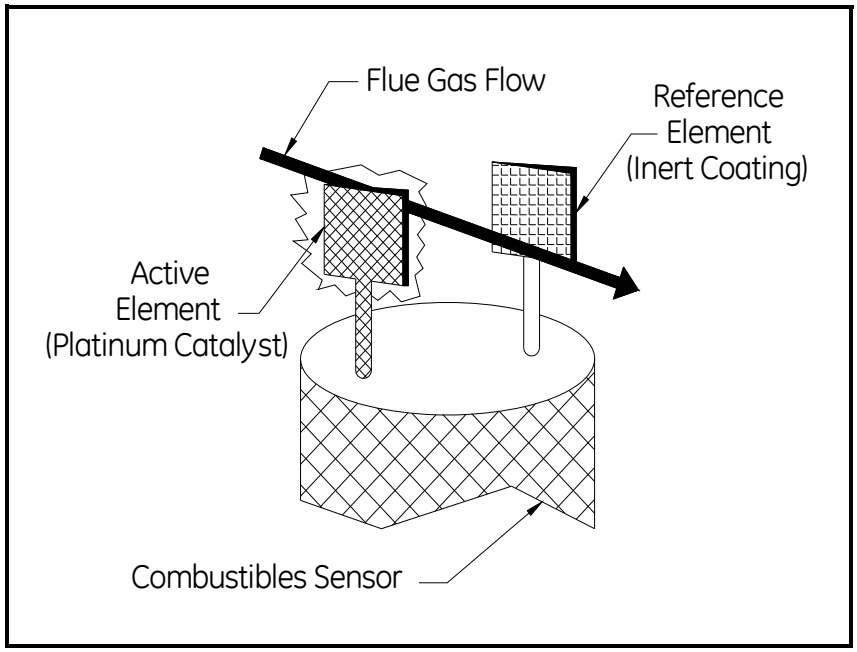

Figure 7: Combustibles Detector Elements

The resulting temperature differential between the active and reference elements is proportional to the concentration of combustibles in the sample, and a corresponding resistance change is then converted into a reading of parts per million by volume (ppm_V) of combustibles.

Chapter 2. Installation

2.1 Overview

This chapter provides a general description of the standard (weatherproof) FGA 300H and explosion-proof (flameproof) FGA 300HX, and gives directions on how to install, wire, and set up each model for operation.

Note: *If more than one analyzer system is being installed, be aware that each system is a matched set (i.e., each Remote FTC Box, probe, probe sleeve and Display Console must be matched to a specific analyzer). Refer to tags on the box, probes, sleeves, displays and analyzers in order to match the units correctly.*

IMPORTANT: *For compliance with the European Union's Low Voltage Directive (73/23/EEC), the standard 300H requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit. Because the sensor furnace power feed in a remote FTC Box must also be interrupted, a 4-pole disconnect device is required for units so equipped. This does not apply to the flameproof 300HX.*

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

WARNING! Power up the FGA 300H(X) as quickly as possible after installation. If the analyzer is left installed without power, the unit's components become susceptible to acid condensation that will cause corrosion.

Be sure to observe all installation limits and precautions described in this chapter. Pay particular attention to the temperature limitations for the Furnace Temperature Control (FTC) Board.

WARNING! To ensure safe operation of the FGA 300H(X), the unit must be installed and operated as described in this manual. Also, be sure to follow all applicable local safety codes and regulations for installing electrical equipment.

All procedures should be performed by trained service personnel.

2.2 Configuration Options

2.2.1 Standard (Weatherproof) Enclosure

The standard (weatherproof) configuration consists of two attached boxes: the Sample System Compartment, which houses the manifold and the sample system, and the smaller Accessory Box (with a front window for viewing the operation light), which contains the terminal blocks and usually a local FTC board (see Figure 8).

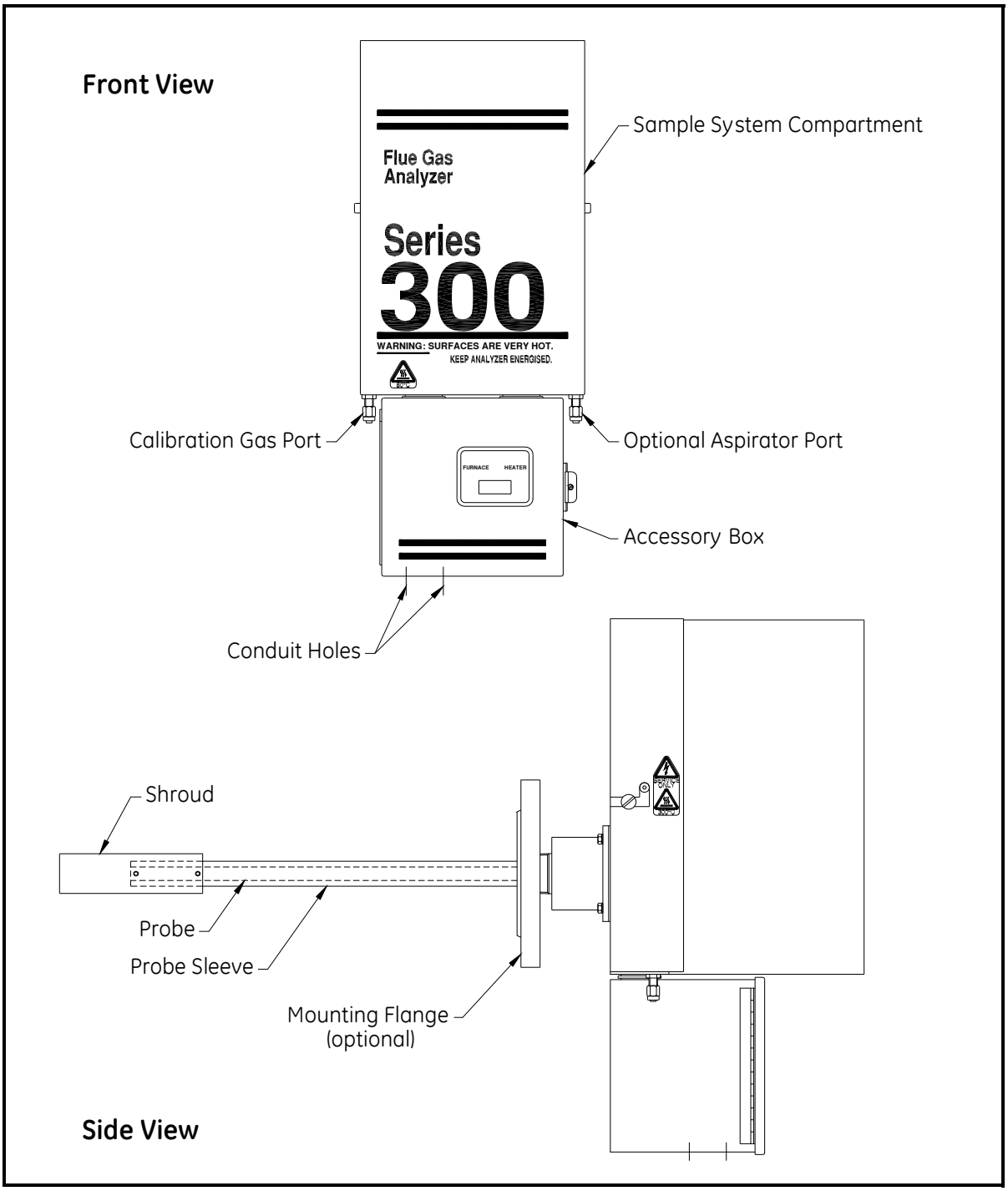

Figure 8: Standard (Weatherproof) Model

2.2.2 Sample System

The sample system consists of a sampling inlet tube, a heater block with thermostat, an oxygen sensor, a sensor furnace, a convection loop to circulate the sample gas, and, if ordered, a combustibles detector (see Figure 9).

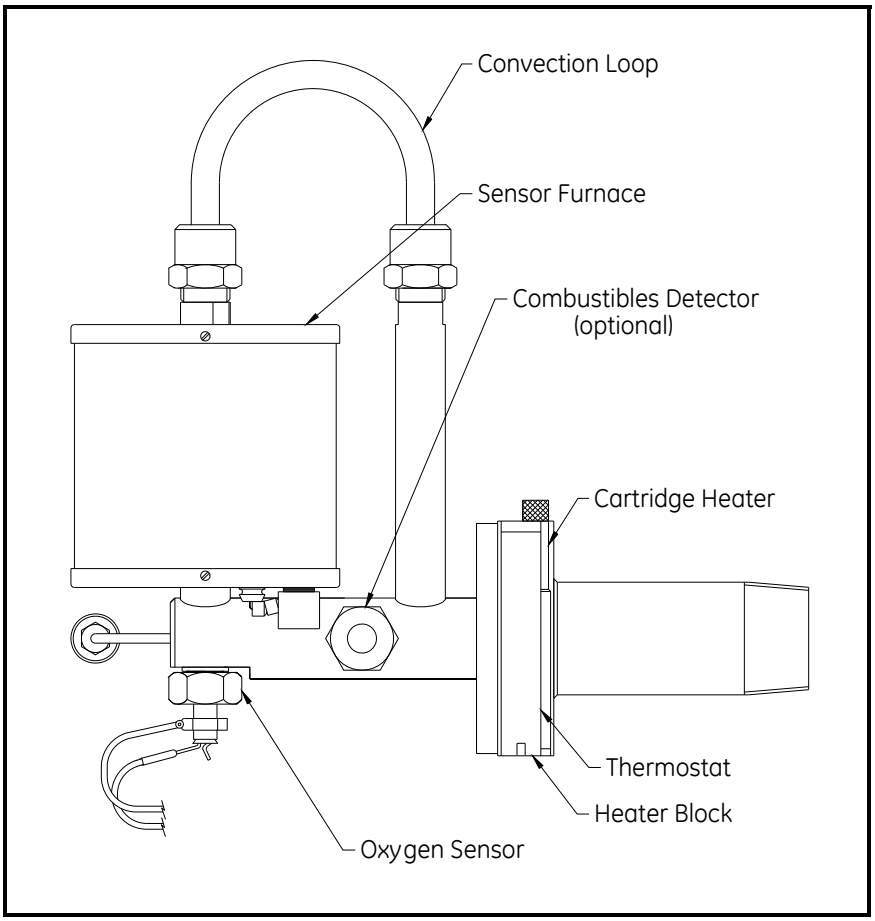

Figure 9: Standard Sample System

2.2.3 Remote FTC Box

For explosion-proof (flameproof) units and for installations where the ambient temperature exceeds 70°C, the FTC circuit board must be mounted in a Remote FTC Box. The Remote FTC Box may be ordered in either a standard (weatherproof) or explosion-proof (flameproof) enclosure (see Figure 10).

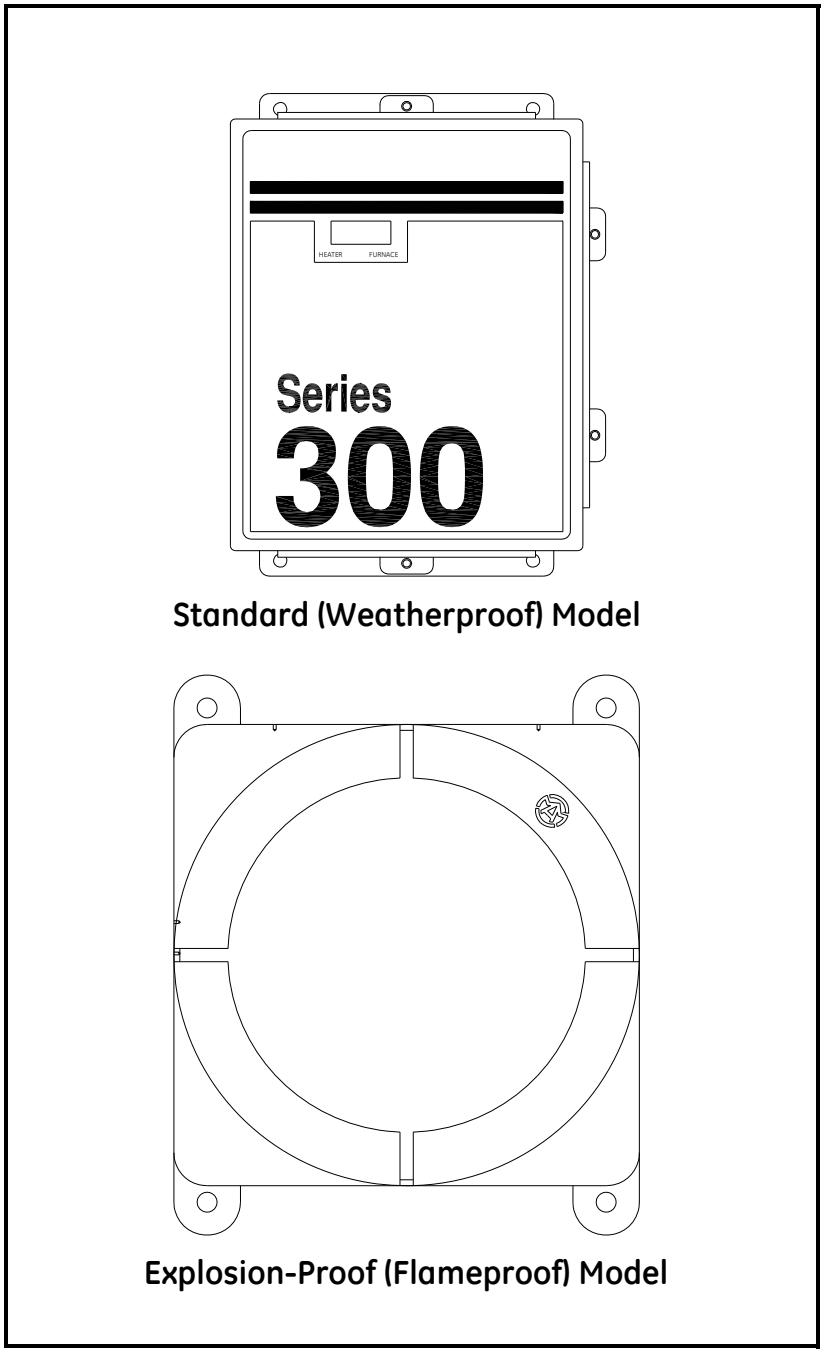

Figure 10: Remote FTC Box Enclosures

2.2.4 Explosion-Proof (Flameproof) Enclosure

The explosion-proof (flameproof) FGA 300HX consists of two attached boxes: a larger Sample System Compartment that contains the manifold assembly and the sample system; and a smaller Accessory Box that contains the analyzer terminal block. See Figure 11. The Remote FTC Box (shown in Figure 10 on page 12) is also included as part of the explosion-proof (flameproof) system configuration.

Note: *With both the standard (weatherproof) and explosion-proof (flameproof) models, an additional box, the display console, may be included.*

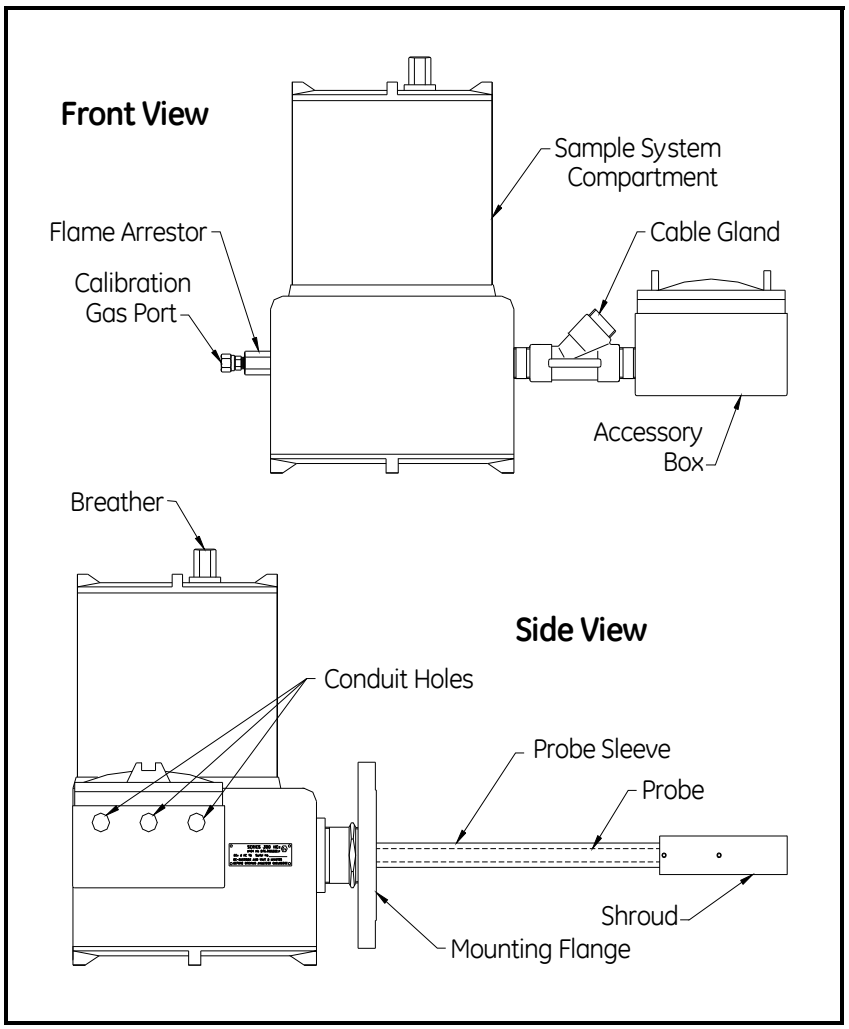

Figure 11: Explosion-Proof (Flameproof) Model

2.2.5 NPT Probe

Included as part of the analyzer are the 1/4" NPT probe and the 3/4" NPT probe sleeve. The probe and probe sleeve carry the sample gas into and out of the analyzer (see Figure 12). 300H(X) units intended for operation at temperatures below 950 °C (1,750°F) include a 32mm (1-1/4 in.) shroud attached to the end of the probe sleeve.

WARNING! Never attempt to attach a shroud to any unit with a non-metallic probe assembly.

Note: *A short section of pipe (for the furnace or boiler wall), two flanges (one for the mounting site and one for the analyzer), studs, nuts, plus a suitable gasket are required for mounting.*

WARNING! Gas flow must be perpendicular to the probe sleeve or, at worst, angled downward and away from the open end of the probe sleeve. Never angle the gas flow into the open end of the probe sleeve (see Figure 12).

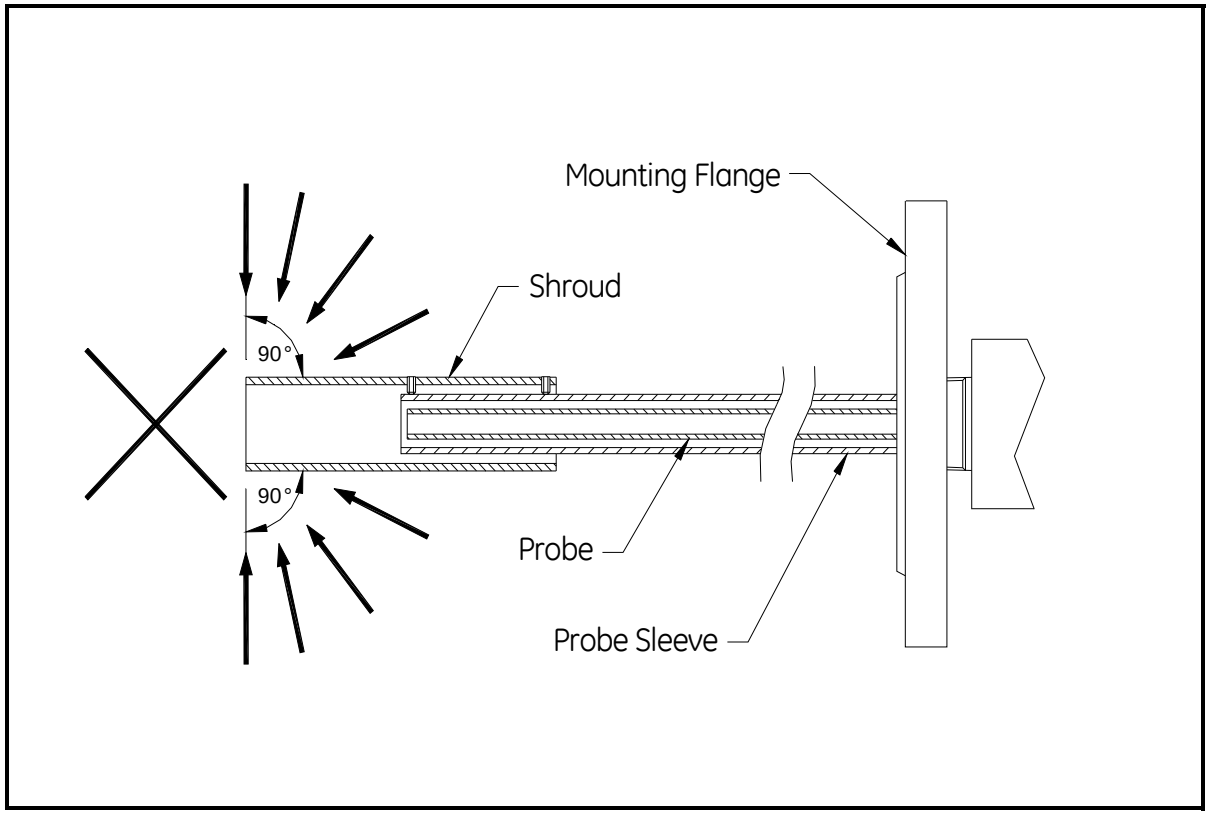

Figure 12: Permitted Gas Flow Angles

2.2.6 Installation Pipe

The standard (weatherproof) 300H is equipped with a short section of 1-1/2" NPTM threaded pipe projecting from the manifold assembly at the back of the analyzer (see Figure 13). On the explosion-proof (flameproof) 300HX, the pipe is 2" NPTM. Use this pipe to attach a user-supplied flange or fixing-plate, or to install the analyzer using one of the flanges available from the factory.

Note: *On request, the factory can supply the analyzer as a flange mounted unit. Standard available options are 3"-300 lb ANSI, 4"-150 lb ANSI and DN80 PN16 flanges.*

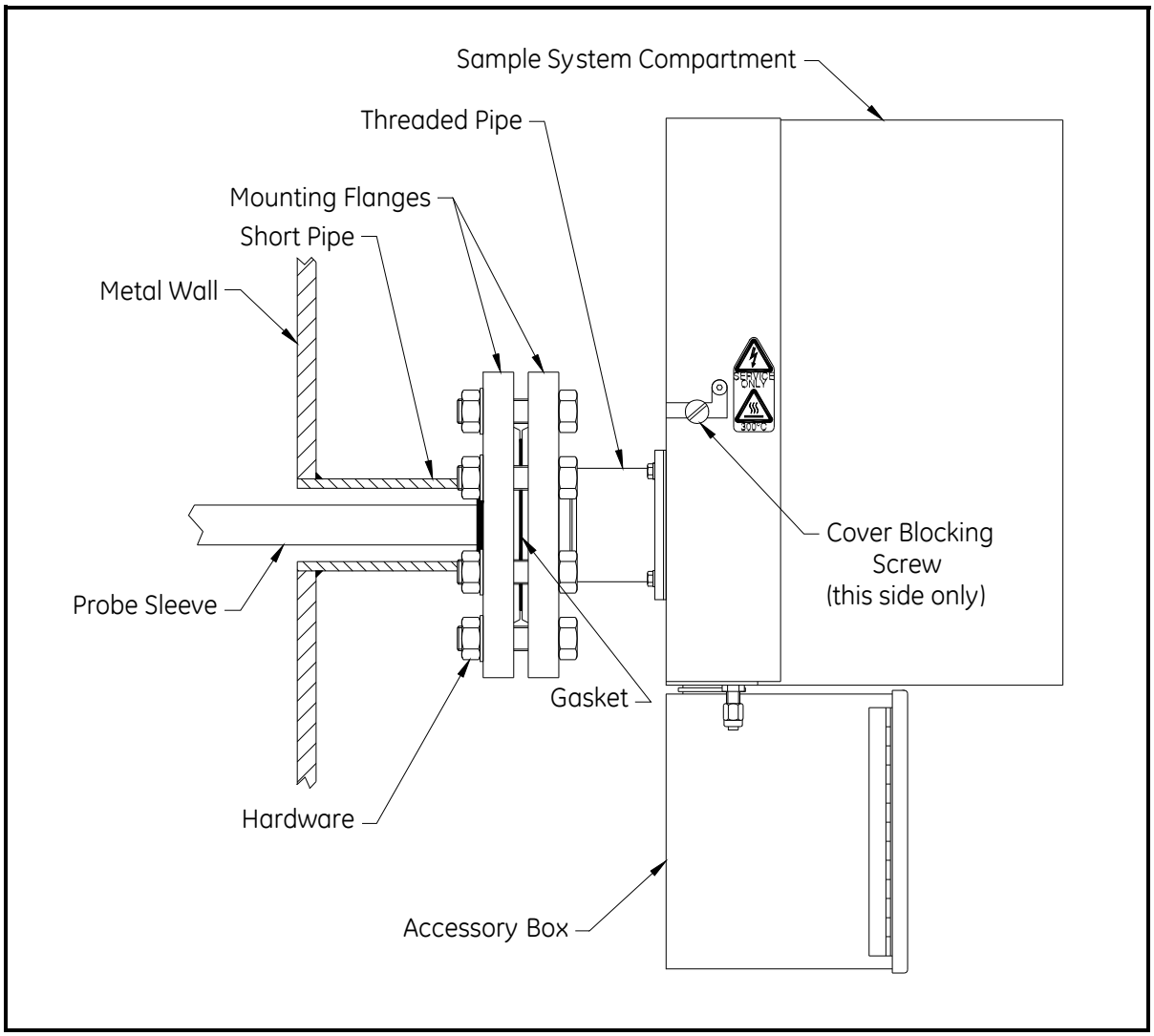

Figure 13: A Typical Flange-Mounted Unit

2.2.7 Operation Voltages

The FGA 300H(X) is wired at the factory for one of four possible operation voltages:

- 100 VAC
- 110/120 VAC
- 220 VAC
- 240 VAC

Note: *Be sure that the line voltage at the intended installation site corresponds to the factory preset voltage setting.*

CAUTION! **To change the voltage setting, contact the factory for instructions and parts. DO NOT make this adjustment on site without first contacting the factory.**

2.3 Installation Site

Install the Main Analyzer Unit in the furnace or boiler wall or in the side of a horizontal or vertical flue duct.

2.3.1 Selecting the Site

Ideally, the probe and probe sleeve should extend approximately 1 ft (30.5 cm) into the flue. Also, the flue gas flow direction should be perpendicular to the probe sleeve or, at worst, angled away from the open end of the probe sleeve (see Figure 12 on page 14).

Note: *Never allow the flue gas flow to be angled directly into the open end of the probe sleeve.*

- *Furnaces:* Locate the analyzer close to the combustion zone, typically within the radiant section and always before the convection section. Because of the high temperatures in such a location, probe material selection should be a primary concern.

Note: *If the ambient temperature near the probe can exceed 950°C (1750°F), a high temperature probe assembly is required.*

- *Boilers:* The analyzer is best located downstream of the main heater and just before the economizer air heater, if there is one. The analyzer should not be placed downstream of any air heater because of possible air leaks, which will cause inaccurate readings.

In general, the sample point should be an area of *high turbulence*, which will ensure a good homogeneous mixture of the flue gases. Conditions to be avoided would include *air leaks* upstream of the sample point and *dead spaces* in the vicinity of the sample point.

2.3.2 Preparing the Site

Preparation of the installation site should include the following steps (see Figure 14 on page 18):

1. At the chosen analyzer location on the furnace or boiler wall or on the side of a horizontal or vertical flue duct, drill a hole of the proper diameter to accommodate a short length of pipe having at least a 4.8 cm (1.875 in.) inside diameter. A 2 in. length of Schedule 80 pipe is recommended for this purpose.
2. Weld the short pipe into the hole. The pipe should be long enough to provide at least a 10 cm (4 in.) clearance between the mounting surface and the mating flange installed in the next step.

Note: *For installation in a masonry wall, the short pipe should extend through the wall to prevent the probe and sleeve from becoming trapped, if the wall should crumble.*

3. Weld a mating flange onto the pipe section. This flange, as well as a mounting flange for the Main Analyzer Unit and a suitable flange gasket, may be ordered with the FGA 300H(X) to ensure a proper match of the mounting components.

2.3.2 Preparing the Site (cont.)

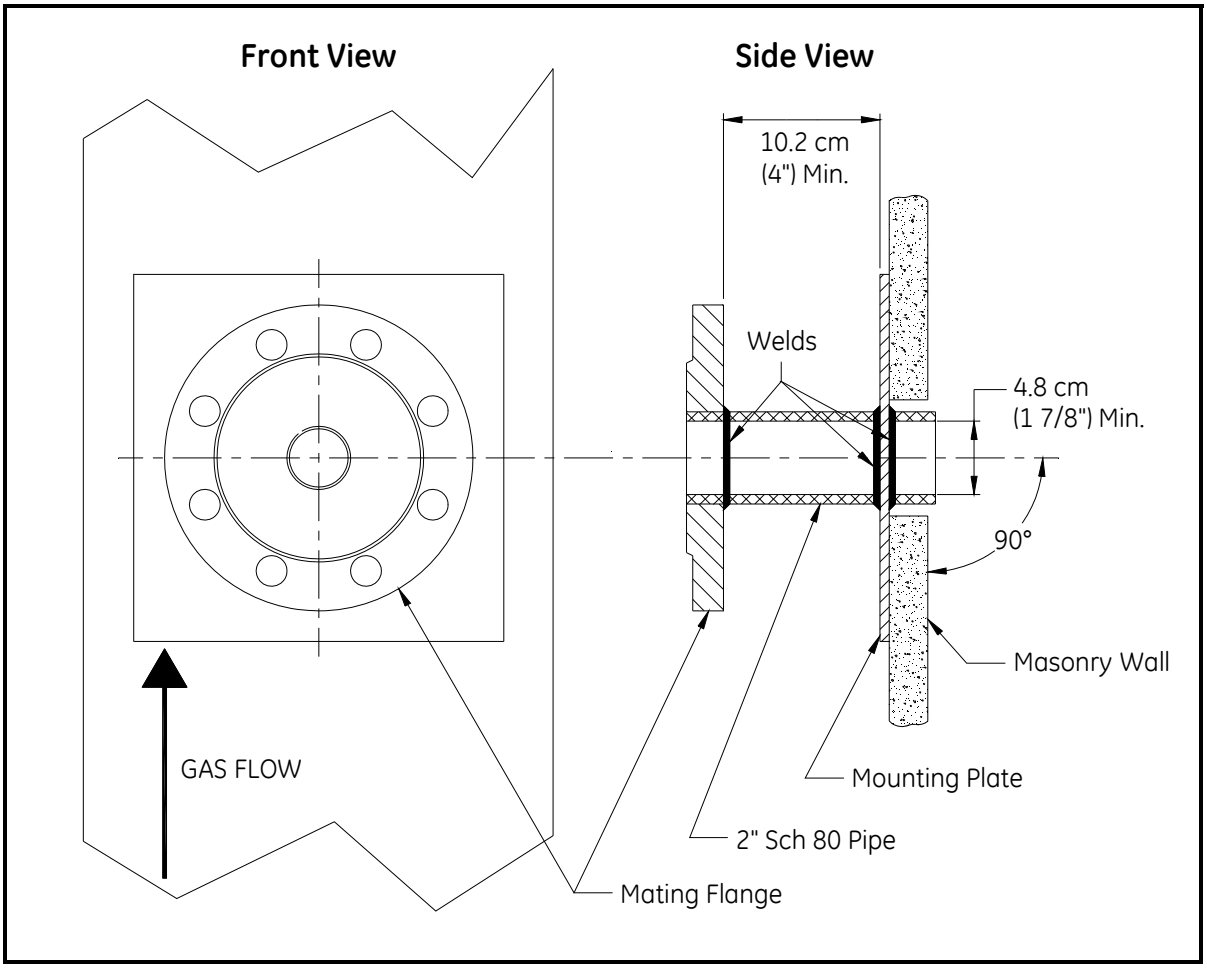

Figure 14: Installed Pipe and Mating Flange

The mating flange should be positioned so that its bolt holes straddle the vertical and horizontal center lines of the mounting opening (see Figure 14). If the unit is ordered with an installed mounting flange, the mating flange alignment shown in Figure 14 will ensure that the analyzer is properly oriented. In addition, make certain that the mating flange is mounted so that the analyzer is vertical and not tilted when it is bolted in place.

CAUTION! **The mounting flange on a standard 300H may be rotated readily, but rotating the flange on an explosion-proof (flameproof) 300HX may cause the manifold to rotate inside the case. Take extreme care to avoid this, as the damage so caused to the internal piping is NOT covered under the warranty.**

2.4 Installing the Probe and Probe Sleeve

CAUTION! Do not use teflon tape on the threads of the probe components during assembly. Teflon tape will melt at the normal probe operating temperature.

For optimum performance, the probe sleeve should extend approximately 1/3 of the way across the flue duct. If possible, the insertion distance should not be less than 30 cm (1 foot).

Confirm that the probe and sleeve are the correct lengths. Then, refer to Figure 15 on page 20 and complete the following steps:

1. As shown in Figure 15 on page 20, attach a flange or fixing-plate to the rear of the Main Analyzer Unit. Orient the flange mounting holes to coincide with the holes in the existing mating flange (see Figure 14 on page 18).

2. Thread the probe and then the probe sleeve into the manifold assembly located in the rear of the analyzer. When properly installed, the probe sleeve should extend approximately 3 mm (.12 in.) beyond the end of the probe.

CAUTION! Do not install a cold probe and/or sleeve into a hot manifold, as the threads will expand and seize upon warming. If such a situation is unavoidable, thread the components loosely into the manifold and allow to warm for a few minutes before fully tightening.

Note: *As it is unnecessary to make the sample probe threading leak-tight, do not use a thread sealant on the threads. However, a dry, high-temperature, graphite-based lubricant may be used.*

3. Units intended for operation at temperatures below 950°C (1,750°F) include a 32mm (1-1/4 in.) shroud attached to the end of the probe sleeve. Secure the shroud to the end of the probe sleeve by tightening the six (6) set screws.

IMPORTANT: *Never attempt to install a shroud on a non-metallic probe assembly, as the probe sleeve will crack.*

CAUTION! If the analyzer contains a combustibles detector, do not use silicon-based sealers or lubricants on any part of the analyzer. The presence of silicon in the analyzer will damage the combustibles detector.

2.4 Installing the Probe and Probe Sleeve (cont.)

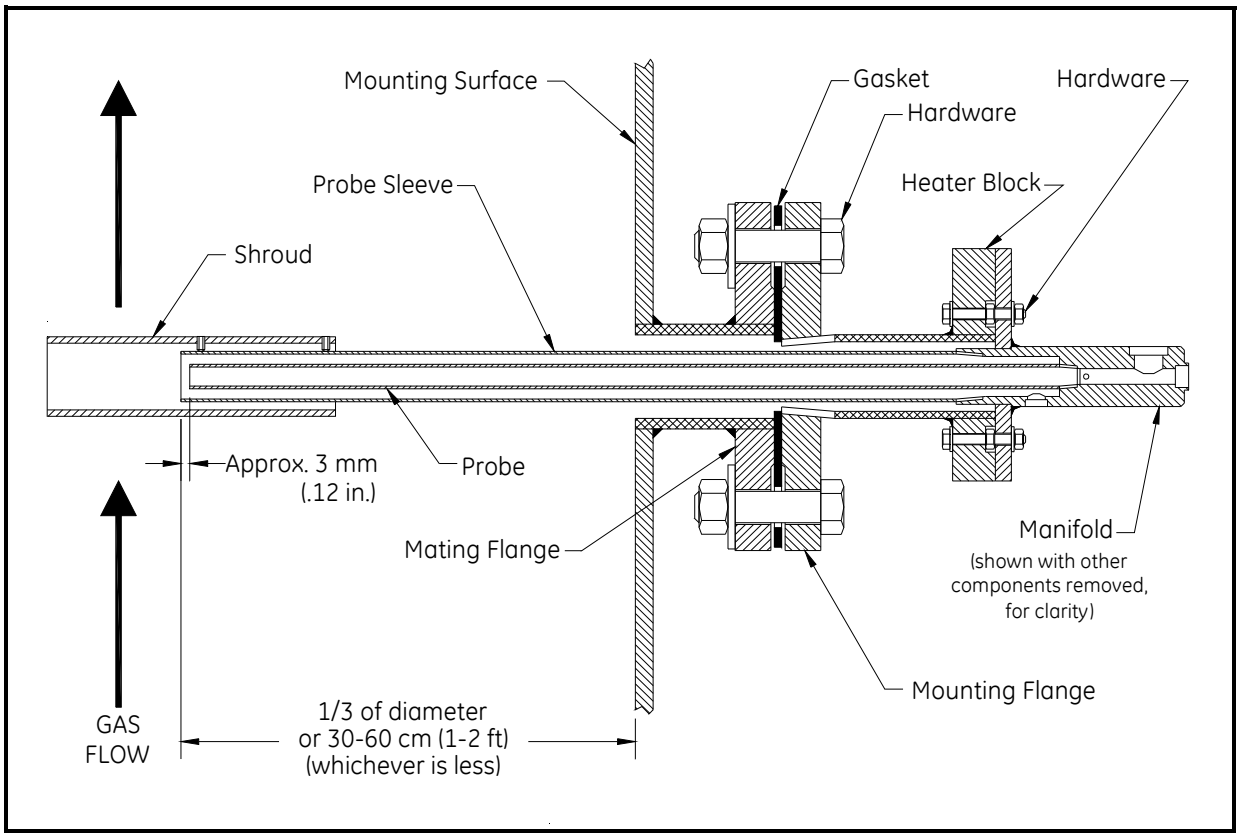

Figure 15: Sample Probe Assembly

2.5 Installing the System

Note: *If more than one analyzer system is being installed, be aware that each system is a matched set (i.e., each Remote FTC Box, probe, probe sleeve and Display Console must be matched to a specific analyzer). Refer to tags on the box, probes, sleeves, displays and analyzers in order to match the units correctly.*

IMPORTANT: *For compliance with the European Union's Low Voltage Directive (73/23/EEC), the standard 300H requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit. Because the sensor furnace power feed in a remote FTC Box must also be interrupted, a 4-pole disconnect device is required for units so equipped. This does not apply to the flameproof 300HX.*

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

2.5 Installing the System (cont.)

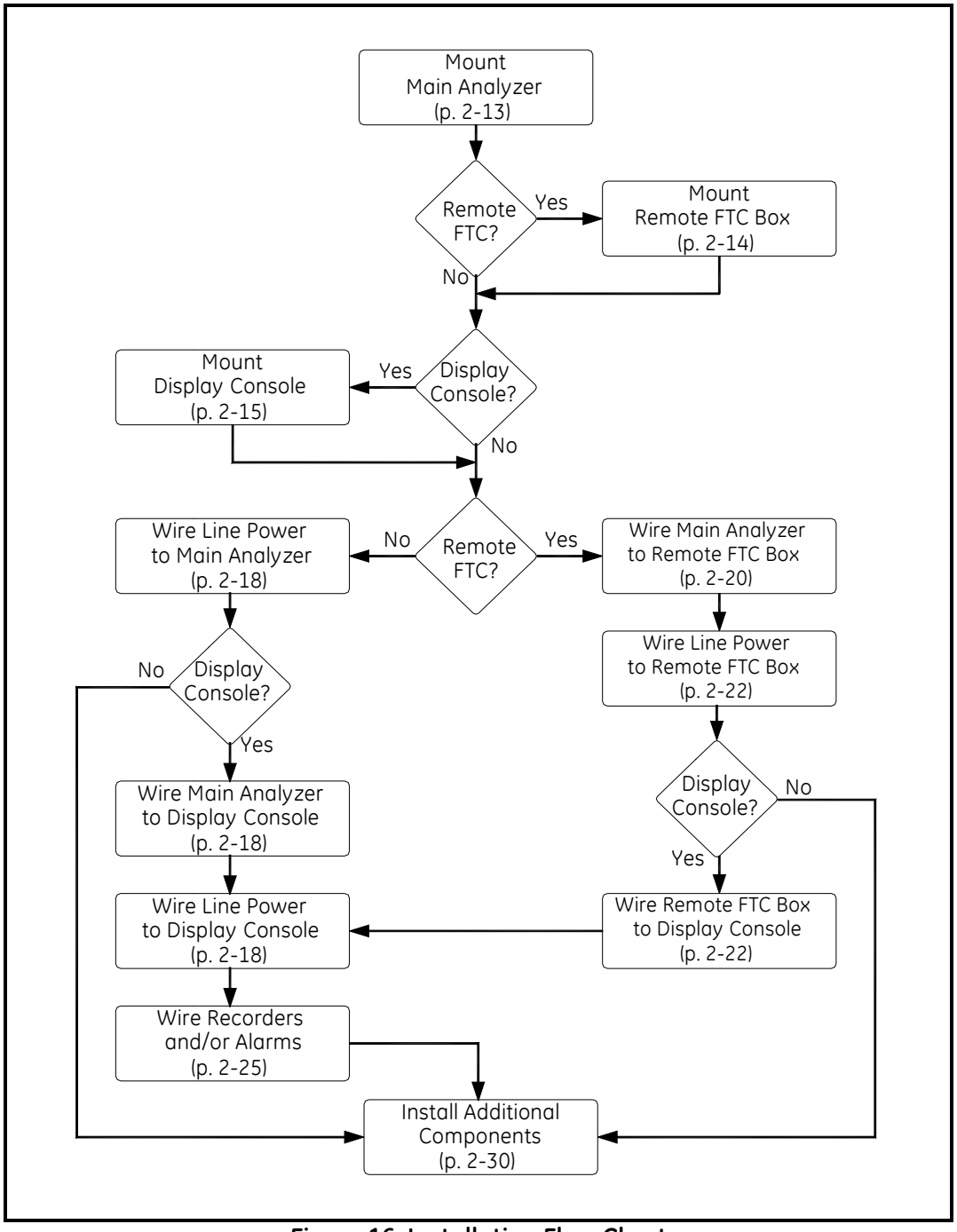

Figure 16: Installation Flow Chart

2.5.1 Mounting the Analyzer

After installing the probe and probe sleeve into the analyzer as described in the previous section, mount the analyzer as follows:

1. Slide a suitable high-temperature gasket over the probe assembly so that it rests against the mounting flange on the rear of the main analyzer assembly.

Note: *If the mating flange was purchased with the analyzer, an appropriate gasket is included.*

2. Insert the probe and sleeve into the hole in the furnace/boiler wall until the gasket is sandwiched between the two flanges.
3. Secure the analyzer in place by fitting bolts into the matching flange holes and fastening the bolts with washers and nuts. Upon insertion, the two flanges should fit together with the gasket clamped between them (see Figure 15 on page 20).

CAUTION! **To prevent corrosion, the analyzer must be powered up immediately after being mounted and the power must remain on at all times. If the power must be removed for more than thirty minutes, purge the analyzer through the calibration port with a continuous flow of instrument air at a minimum rate of 150 cc/min (0.3 SCFH).**

4. An explosion-proof (flameproof) analyzer requires a constant reference air flow. Connect a 50 cc/min atmospheric air line (20.9% oxygen) to the purge connection (see Figure 17).

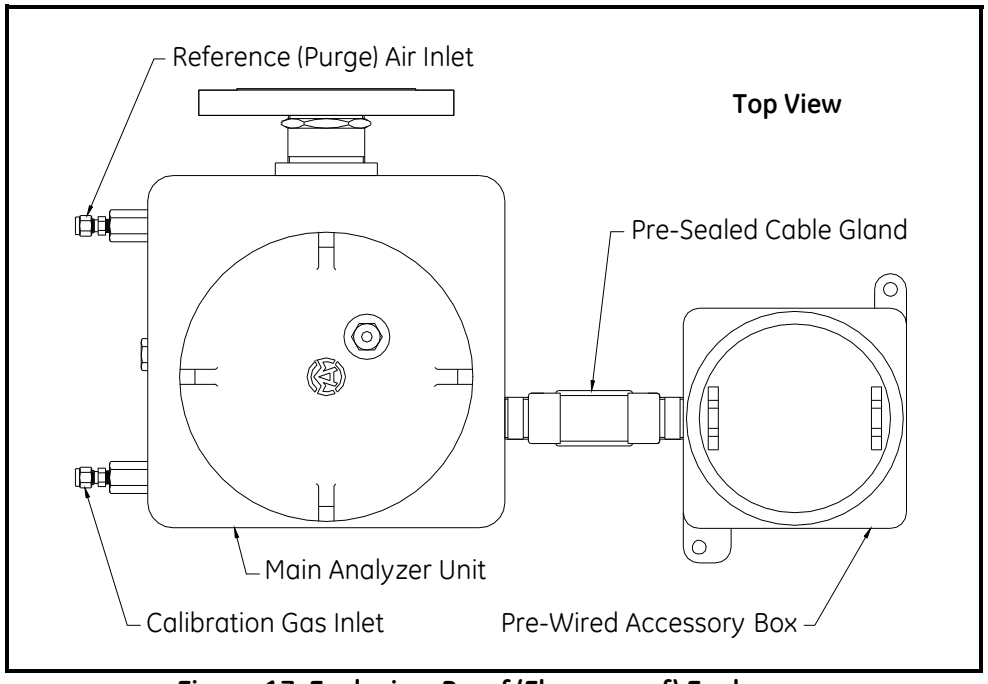

Figure 17: Explosion-Proof (Flameproof) Enclosure

2.5.2 Mounting the Remote FTC Box

In addition to the *Main Analyzer Unit* and the attached *Accessory Box*, the 300H(X) system may include a separate *Remote FTC Box*. If so, mount the remote FTC Box as close to the analyzer as possible, and connect it to the Accessory Box with 0.75 mm^2 (or 18 awg) cable, for distances up to 25 meters (80 feet).

Note: *The remote FTC Box may be located up to 40 meters (110 feet) from the Accessory Box, if 1 mm^2 (or 16 awg) cable is used.*

The ambient temperature of the mounting location should not exceed 70°C (160°F). If the ambient temperature at the proposed location is expected to exceed 70°C (160°F), the enclosure should be located where the temperature will be within the remote FTC's specified temperature limits of -25° to 70°C (-15° to 160°F). Refer to Appendix B, *Mounting Dimensions and Drawings,* for the Main Analyzer Unit and Remote FTC Box mounting dimensions.

2.5.3 Mounting the Display Electronics Console

Ideally, the 300D *Display Electronics Console* should be located within 5 meters (15 feet) of the FTC Board. However, the use of shielded cable permits distances up to 150 meters (500 feet), for units equipped with both the oxygen sensor and combustibles detector. If a greater distance is required, contact the factory for assistance. See Appendix B, *Outline and Mounting Dimensions,* for the Display Electronics Console mounting dimensions.

Note: *For units <u>without</u> the optional combustibles detector, the Display Console may be located up to 600 meters (2,000 feet) from the FTC Board without significant signal degradation, if shielded cable is used.*

The Display Console has four rotary switches located on its printed circuit board which are used to set:

- fuel type (Switch 1)
- display parameter (Switch 2)
- analog output range (Switch 3)
- alarm level (Switch 4)

These switches have been pre-set at the factory according to the customer's specifications; however, they can be reset as required. To reset the rotary switches, see Appendix A, *Rotary Switch Settings*.

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

<u>WARNING!</u> The above electric shock symbol is also applied next to screws that secure components essential to the double insulation requirements of the EN61010 standard. Removal of these screws and/or components may result in a safety hazard.

2.5.4 Making Wiring Connections

1. **Local FTC:** To wire units with the FTC circuit board in the Main Analyzer Accessory Box, refer to page 26 and complete the following steps:
   - Wire the 300H(X) Accessory Box to the 300D Display Console.
   - Connect power to both the 300H(X) and the 300D Display Console.
2. **Remote FTC:** To wire units with the FTC circuit board in a Remote FTC Box, refer to pages 2-20 through 2-24 and complete the following steps:
   - Wire the 300H(X) Accessory Box to the Remote FTC Box.
   - Wire the 300D Display Console to the Remote FTC Box.
   - Connect power to both the Remote FTC Box and the 300D Display Console.

Additional connections for optional recorders and alarms are shown later in this section. Refer to Appendix F, *Previous Configurations*, for earlier versions of the FGA 300H(X).

WARNING! **In order to meet CE Mark requirements, all cables must be installed as described in Appendix E, *CE Mark Compliance*.**

IMPORTANT: *For compliance with the European Union's Low Voltage Directive (73/23/EEC), the standard 300H requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit. Because the sensor furnace power feed in the remote FTC Box must also be interrupted, a 4-pole disconnect device is required. This does not apply to the flameproof 300HX.*

WARNING! **To ensure safe operation of the FGA 300H(X), the unit must be installed and operated as described in this manual. Also, be sure to follow all applicable local safety codes and regulations for installing electrical equipment. All procedures should be performed by trained service personnel.**

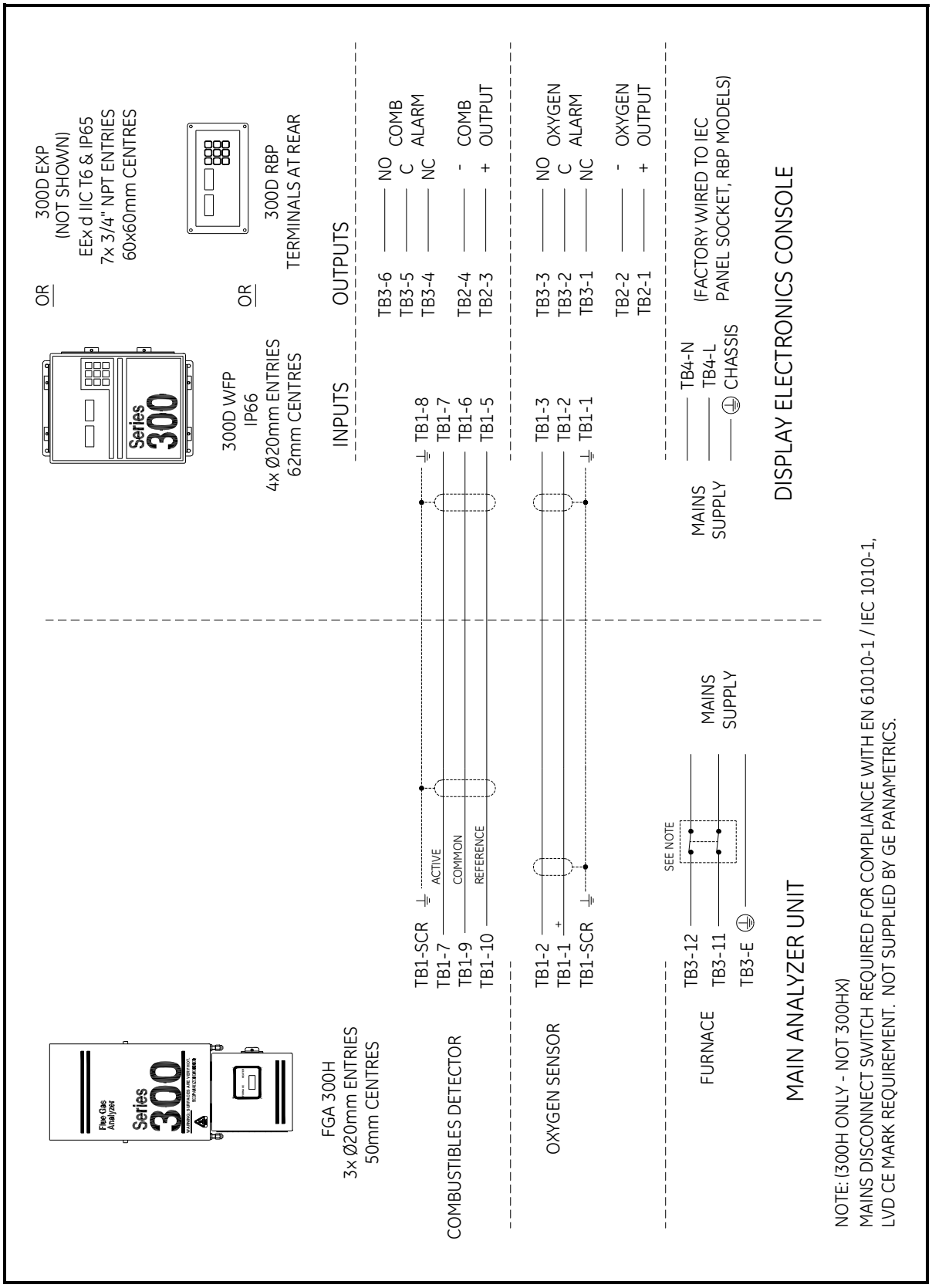

Figure 18: Interconnection Diagram for Standard 300H FGA (with Local FTC)

2.5.5 Wiring a 300H(X) with Local FTC

In most instances, the FTC circuit board is mounted in the Accessory Box which is attached to the bottom of the Main Analyzer Unit. For these units, complete the following section.

The 300H standard weatherproof model is wired at the factory according to the specifications in your order. All that is required is to wire the Accessory Box terminal block (TB1) to the Display terminal block (TB1), and then connect both to power supplies.

2.5.5a Connecting the Display

Make wiring connections from the display terminal block (TB1) to the FTC terminal block (TB1) located in the Accessory Box.

Refer to Figure 18 on page 25, Figure 19 on page 27, and Table 1 for pin connections.

Table 1: Display to Local FTC Box Connections

Connect:	Display Pin# (TB1)	Accessory Box Pin# (TB1)
Oxygen Sensor (+)	2	1
Oxygen Sensor (-)	3	2
Combustibles Detector (Reference)	5	10
Combustibles Detector (Common)	6	9
Combustibles Detector (Active)	7	7
Display Screen	1, 4, 8	⏚

2.5.5b Connecting the Power

Power must be connected to both the display and the analyzer. Use Figure 18 on page 25, Figure 19 on page 27, and Table 2 to make connections.

Table 2: Power Connections

From: Voltage Supply	To: Accessory Box (TB3)	To: 300D Display (TB4)
Live (+)	11 Live / Phase	2 L
Neutral (-)	12 Neutral	1 N
Ground (⏚)	Earth	(chassis)

⏚ = Protective Conductor Terminal

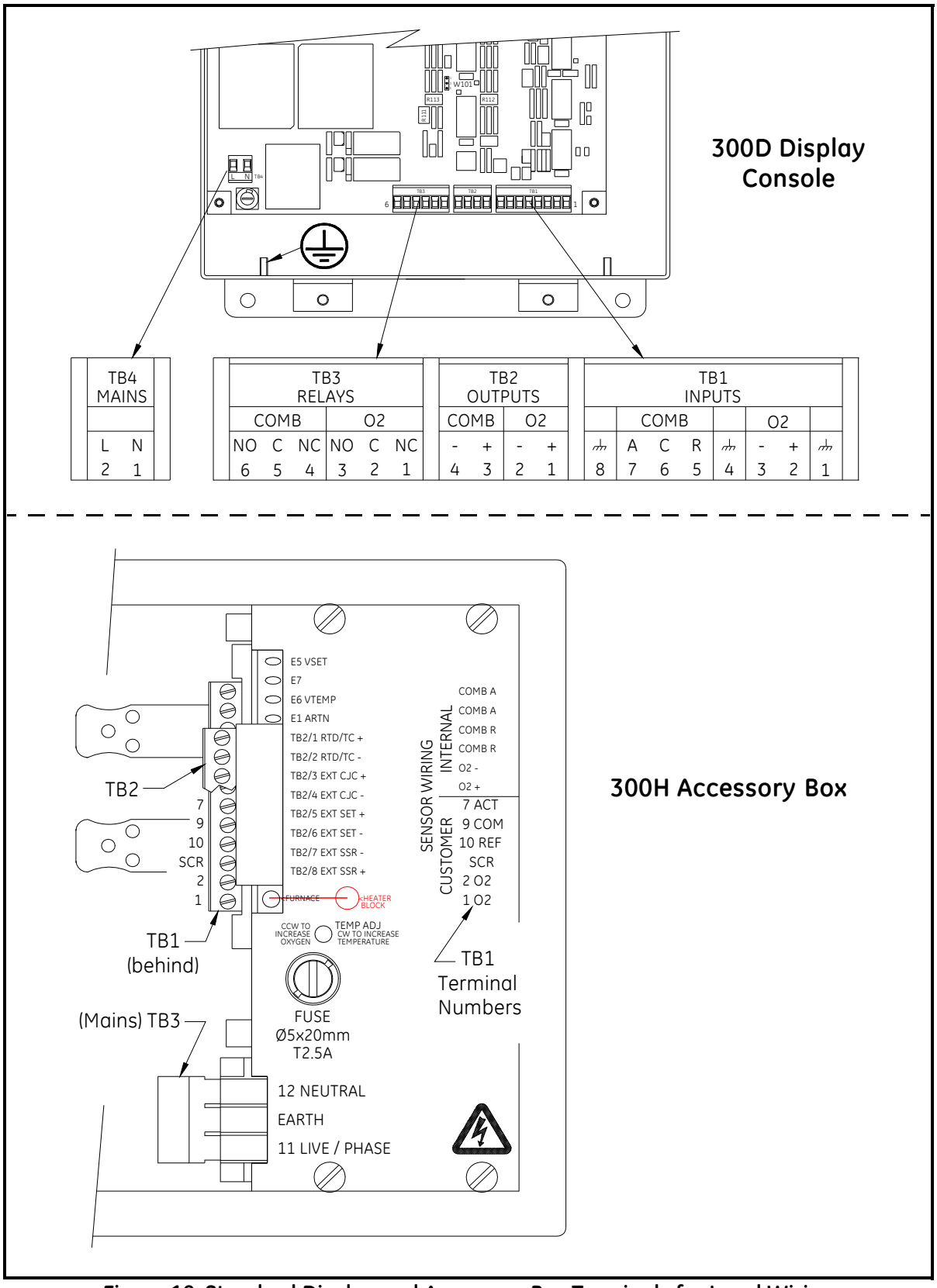

Figure 19: Standard Display and Accessory Box Terminals for Local Wiring

2.5.6 Wiring a 300H(X) with Remote FTC

For units that have the FTC circuit board mounted in a Remote FTC Box, complete the following sections.

Interconnection Diagram, Figure 22 on page 32, has been included for help in making the proper connections. Wiring diagrams, Figure 65 on page 149 and Figure 67 on page 157, which correspond to earlier versions of the 300H FGA can be found in Appendix F.

2.5.6a Connecting the Analyzer to the Remote FTC Box

Make wiring connections from terminal blocks in the *Remote FTC Box* to terminal blocks in the *Accessory Box* (the smaller box which is part of the Main Analyzer Unit). Refer to Figure 20 on page 29 and Table 3 for the terminal block locations and the proper pin connections.

Table 3: Main Analyzer Unit to FTC Box Connections

Connect:	From: Accessory Box	To: Remote FTC Box
Oxygen Sensor	1	1
	2	2
Temperature Sensor	3	3
	4	4
Combustibles - Active	7	7
Combustibles - Reference	9	9
	10	10
Power Supply*	11	11
	12	12
Furnace	14	14
	(12)	(12)
* Since the Main Analyzer Unit receives its power from the Remote FTC Box, an interconnection is required.		

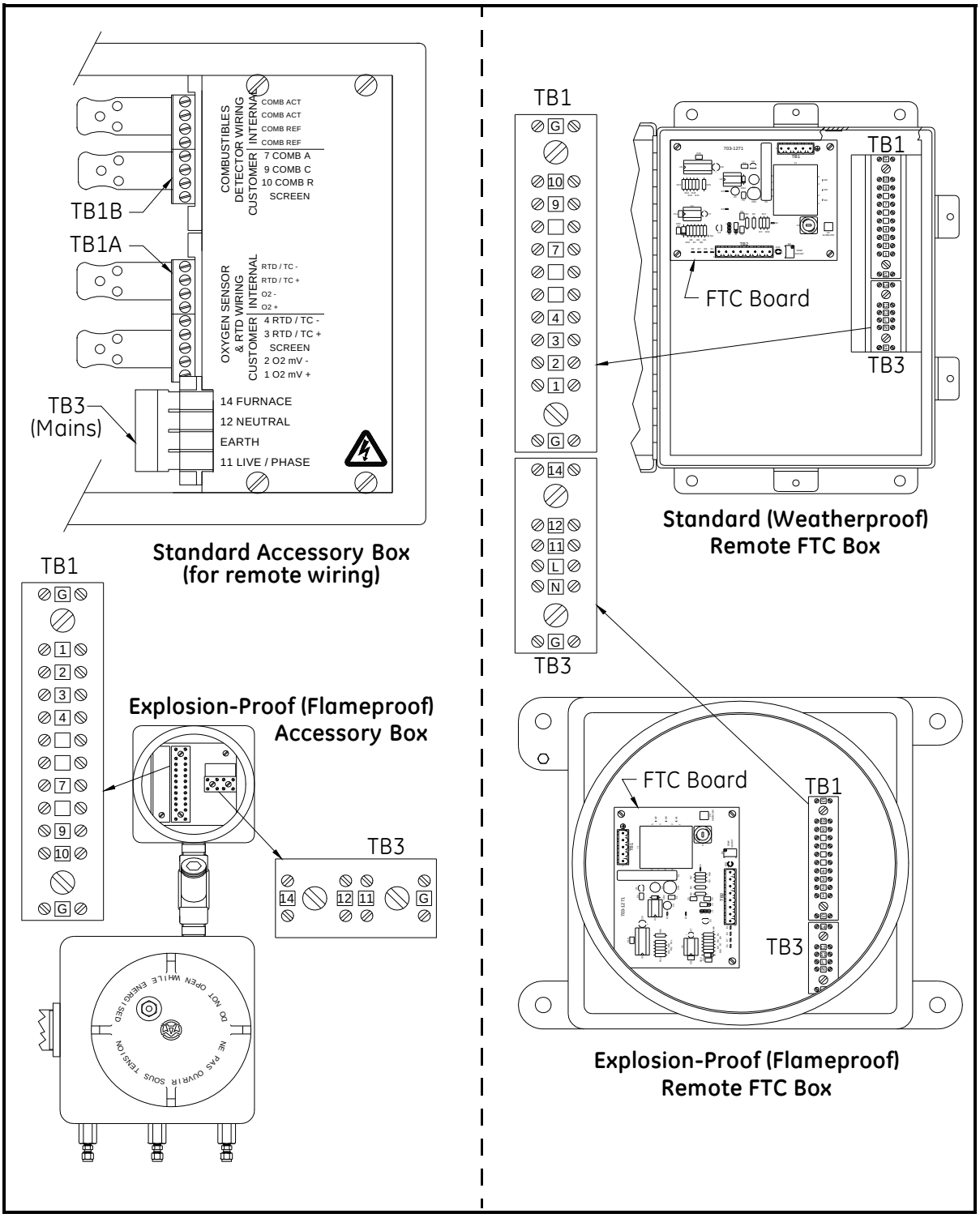

Figure 20: Accessory Box and Remote FTC - Terminal Block Locations

⏚ = Protective Conductor Terminal

2.5.6 Wiring a 300H(X) with Remote FTC (cont.)

2.5.6b Connecting the Display

Make wiring connections from terminal block TB1 in the 300D Display Console to terminal block TB1 in the Remote FTC Box. Refer to Figure 21 on page 31 and Table 4 for the terminal block locations and the proper pin connections.

Table 4: Display to FTC Box Connections

Connect:	Display Pin# (TB1)	Remote FTC Pin# (TB1)
Oxygen Sensor (+)	2	1
Oxygen Sensor (-)	3	2
Combustibles Detector (Reference)	5	10
Combustibles Detector (Common)	6	9
Combustibles Detector (Active)	7	7
Display Screen	1, 4, 8	Ground

Note: *For units fitted with the previous version of the 300D printed circuit board. See Appendix F,* Previous Configurations*, for the layout of this circuit board.*

2.5.6c Connecting the Power

Power must be connected to both the Display Console (TB4) and the Remote FTC Box (TB3). Refer to Figure 21 on page 31 and Table 5 for the terminal block locations and the proper pin connections.

Table 5: Power Connections

From: Voltage Supply	To: FTC Box (TB3)	To: 300D Display (TB4)
Live (+)	L	L
Neutral (-)	N	N
Ground (⏚)	G	(chassis)

⏚ = Protective Conductor Terminal

2.5.6 Wiring a 300H(X) with Remote FTC (cont.)

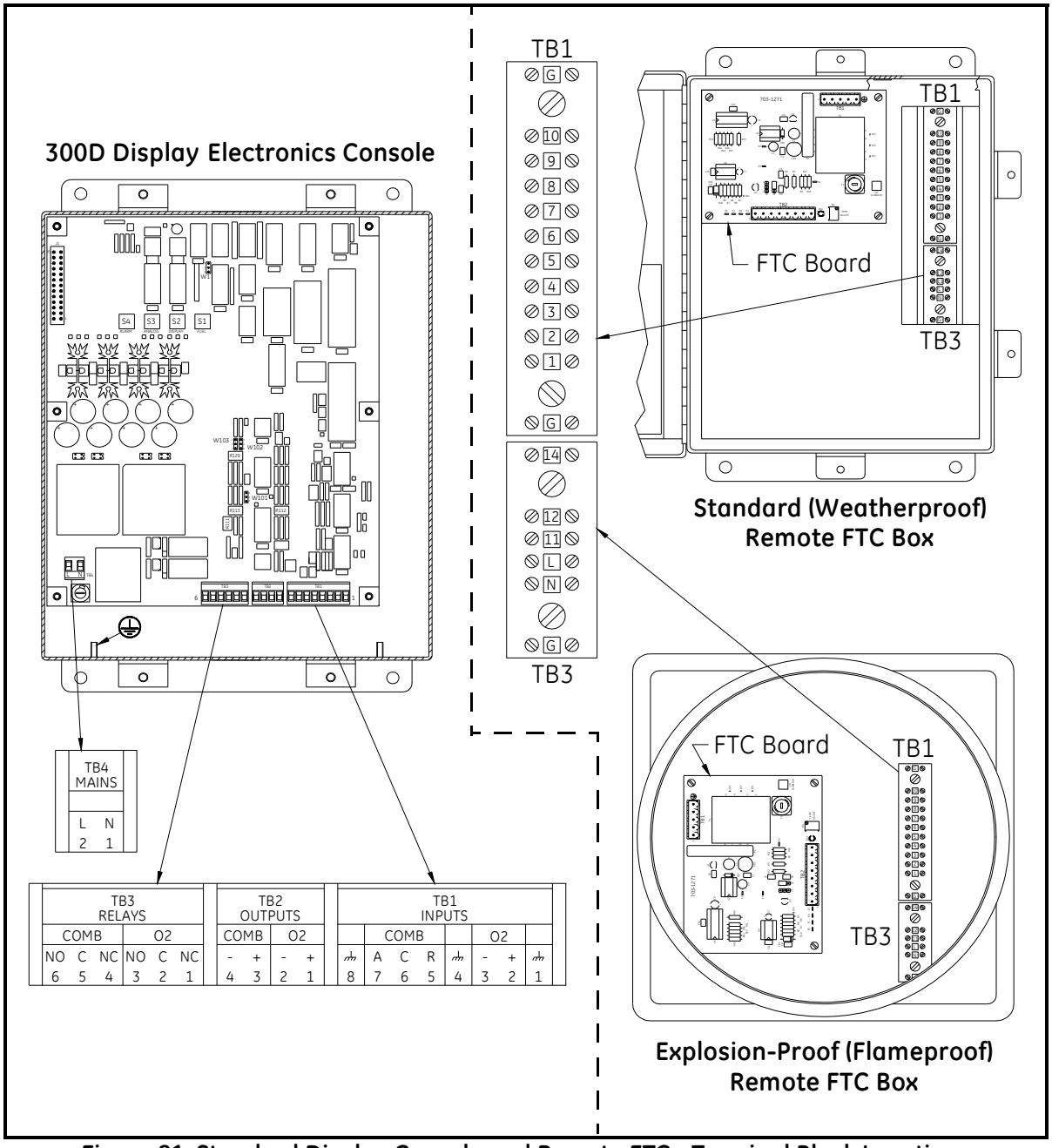

Figure 21: Standard Display Console and Remote FTC - Terminal Block Locations

⏚ = Protective Conductor Terminal

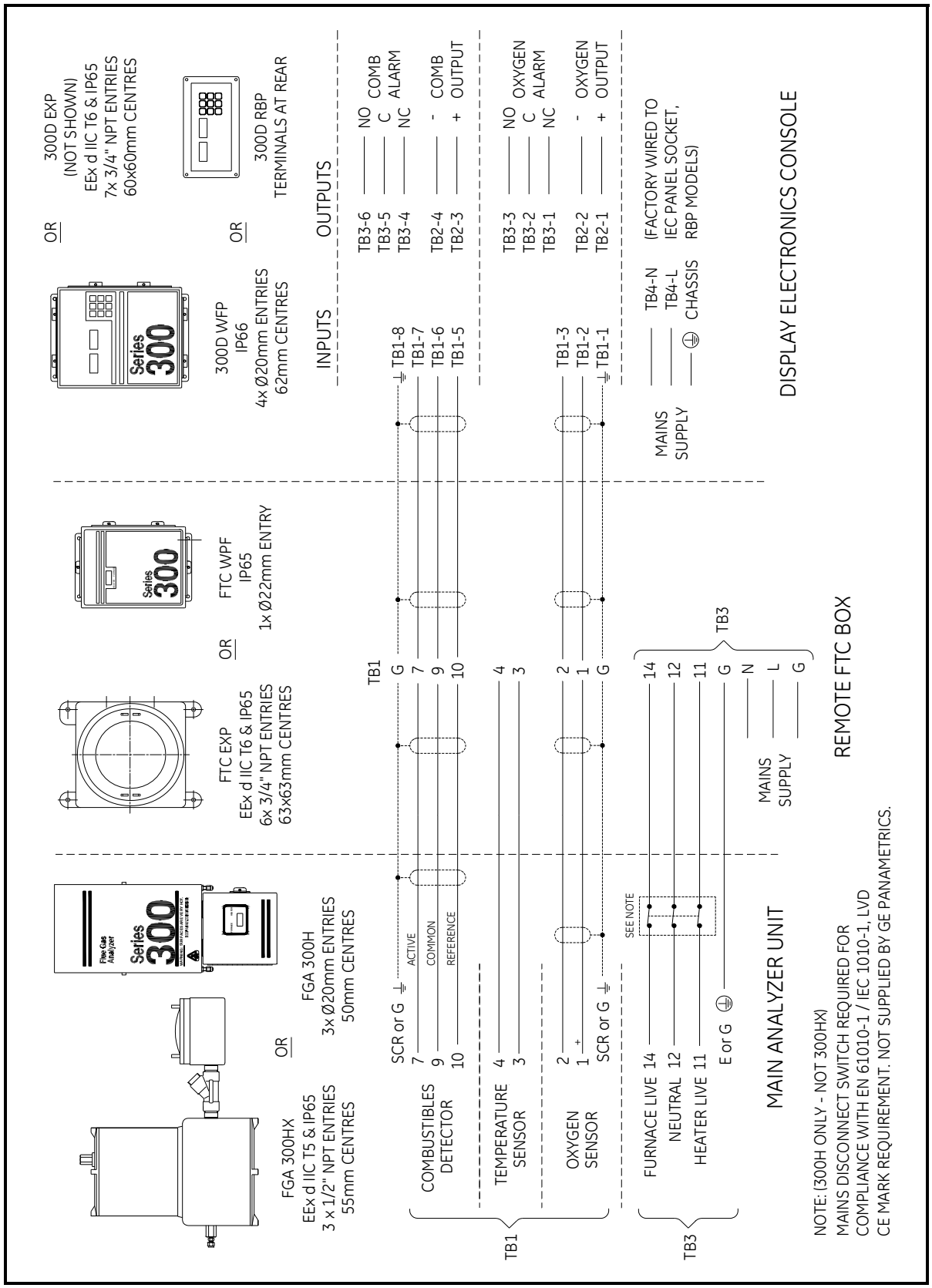

Figure 22: Interconnection Diagram for Main Analyzer with Remote FTC

2.5.7 Connecting Recorders

The 300D Display Console provides a pair of outputs for connecting a recorder to the system. Make the connections to terminal block TB2 on the 300D Display circuit board. The recorder output mode is set to either current or voltage at the factory, prior to shipment. Use Table 6 to make the proper connections, and refer to Figure 21 on page 31 for the terminal block location on the 300D Display circuit board.

Table 6: Recorder Connections

Output Variable	300D Display Pin# (TB2)
Oxygen +	1
Oxygen -	2
Combustibles +	3
Combustibles -	4

The scale for the outputs is either a zero-based linear output (0-20 mA/0-10 V) or an offset linear output (4-20 mA/2-10 V), as specified when ordered. To change the preset output range see Appendix A, *Rotary Switch Settings*.

2.5.8 Connecting Alarms

In order to make alarm connections, a Display Console is required. There is one alarm for the oxygen channel and one for the combustibles channel. Once the alarms are connected, the alarm trip points must be set. Refer to Table 7 and Figure 22 on page 32 to make the proper connections.

Table 7: Alarm Connections

Alarm Output	300D Display Pin# (TB3)
Oxygen - NC	1
Oxygen - C	2
Oxygen - NO	3
Combustibles - NC	4
Combustibles - C	5
Combustibles - NO	6

The next step before using the alarms is setting the alarm trip points for both the oxygen and combustibles channels. Proceed to the appropriate section below to set the desired alarm trip points.

2.5.8 Connecting Alarms (cont.)

2.5.8a Setting the Oxygen Alarm Trip Point

The instructions in this section describe the two steps required to properly set the oxygen alarm trip point:

- Set the alarm trip point to the desired oxygen percentage
- Set the oxygen alarm as either a high or low type

Switch S4 on the 300D Display printed circuit board is used to select the alarm trip point. Each position on switch S4 represents a percentage of the recorder's full analog output range, which is set at the factory using switch S3.

1. Use the following formula to determine the correct analog output trip point, and refer to Table 8 and Figure 23 on page 35 to adjust switch S4 to the required position.

$$\text{Trip Point \%} = \frac{\text{Trip Point O2 \%}}{\text{Full Scale O2 \%}} \times 100$$

For example, if an alarm trip point of **6% oxygen** is desired, use the above equation to find the trip point (60% of full scale range), $\text{Trip Point \%} = \frac{6\ \%}{10\ \%} \times 100 = 60\%$, and set Switch 4 to **position 6**.

Table 8: Rotary Switch S4 Settings

Switch Position	Alarm Trip Point (as % of Full Scale Range)
0	0%
1	10%
2	20%
3	30%
4	40%
5	50%
6	60%
7	70%
8	80%
9	90%
10	100%
11	110%
12	120%

2.5.8 Connecting Alarms (cont.)

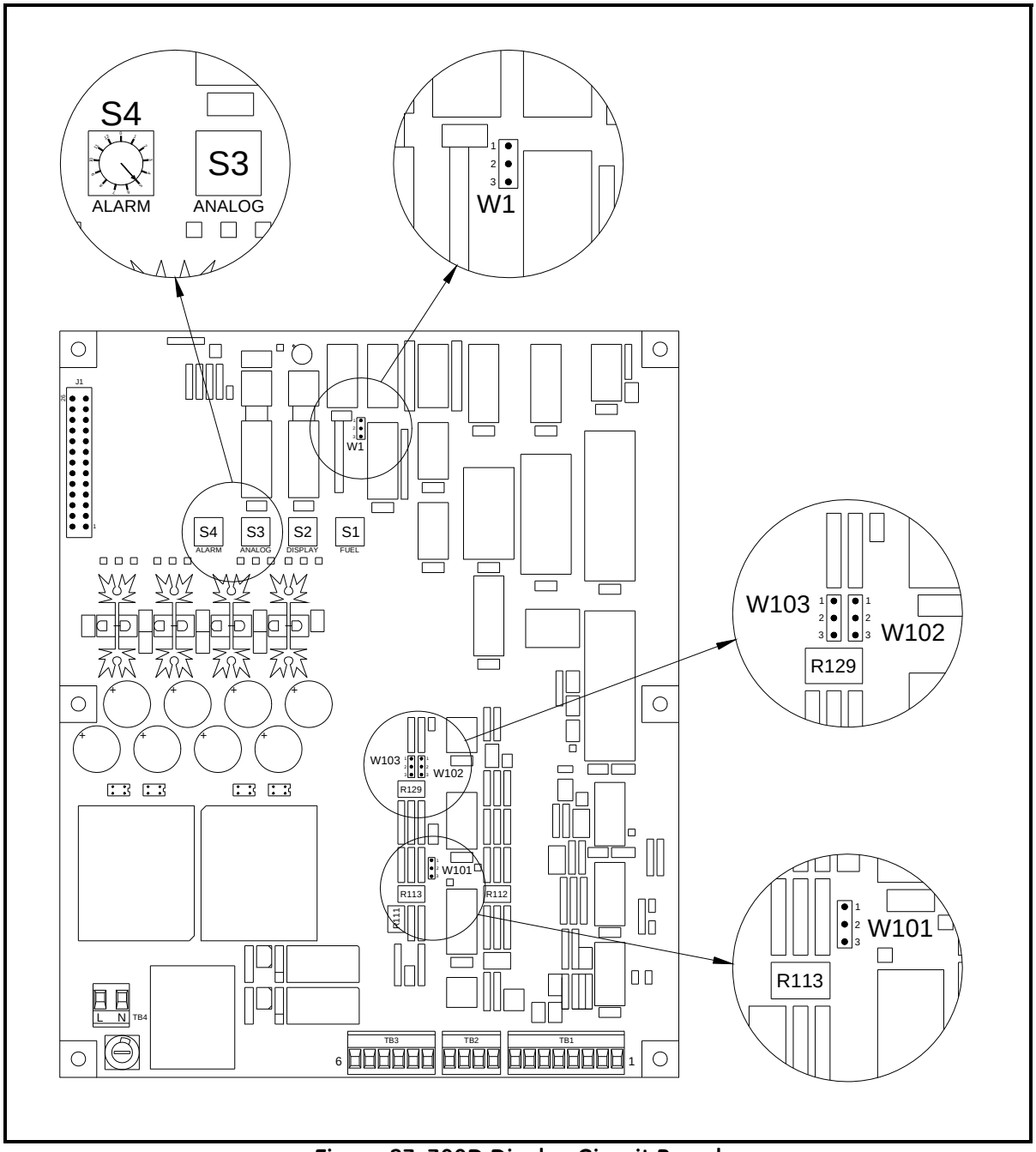

Figure 23: 300D Display Circuit Board

Note: *For units fitted with the previous version of the 300D printed circuit board, see Appendix F,* Previous Configurations, *for the layout of this circuit board.*

2.5.8 Connecting Alarms (cont.)

2.5.8b Setting the Alarm Trigger Mode

After setting the alarm trip point, the alarm trigger mode must be set. The oxygen alarm can be set for either high or low operation.

2. To set the alarm trigger mode, complete the following steps:

a. Locate jumper W1 on the 300D Display printed circuit board. See Figure 23 on page 35.

b. Set jumper W1 to either of the following settings for the desired alarm trigger mode:

- Low Alarm - install jumper in 1/2 position
- High Alarm - install jumper in 2/3 position

A high alarm will activate when the oxygen measurement goes over the alarm trip point and a low alarm will activate when the oxygen measurement goes below the alarm trip point.

2.5.8c Setting the Combustibles Alarm Trip Point

The combustibles alarm trip point is set by using the jumpers and potentiometers on the 300D Display printed circuit board. Complete the following steps and refer to Figure 23 on page 35 to set the combustibles alarm trip point.

1. Move the jumper at location W101 from its original 1/2 position to position 2/3.

2. Adjust potentiometer R113 until the desired alarm trip point, in combustibles ppm_V, appears on the digital display.

3. Set the jumper at location W102 to either of the following settings for the desired alarm mode:

- Low Alarm - install jumper W102 in the 1/2 position
- High Alarm - install jumper W102 in the 2/3 position

A high alarm will activate when the combustibles measurement goes over the alarm trip point and a low alarm will activate when the combustibles measurement goes below the alarm trip point.

4. Move the jumper at location W101 from the temporary 2/3 position back to its original 1/2 position.

2.6 Installing Additional Components

The typical FGA 300H(X) Horizontal Flue Gas Analyzer supplied by GE, consists of three major components:

- Main Analyzer Unit
- Remote FTC Box
- Display Electronics Console

The instructions in this chapter have explained how to install and wire these primary components. However, some additional user-supplied items are recommended to enhance the system. Specifically, the following components may make the system more user-friendly and improve the overall efficiency and reliability of the system:

- Flowmeters
- Pressure Gauges
- Needle Valves
- Piping and Fittings

Since no two installations are identical, it is not possible to provide exact instructions and specifications for this ancillary equipment. However, the system shown in Figure 24 on page 38 should serve as a good general guideline for most situations. This all-inclusive diagram is not intended to imply that all of the components shown are required in every situation. Only those items deemed appropriate for the intended application need be considered.

Note: *Figure 24 on page 38 shows a system with a 300HX explosion-proof (flameproof) unit, a remote FTC Box and a standard Display Console. Although other combinations of standard and flameproof enclosures for these components are possible, the fundamental connections shown in Figure 24 remain unchanged.*

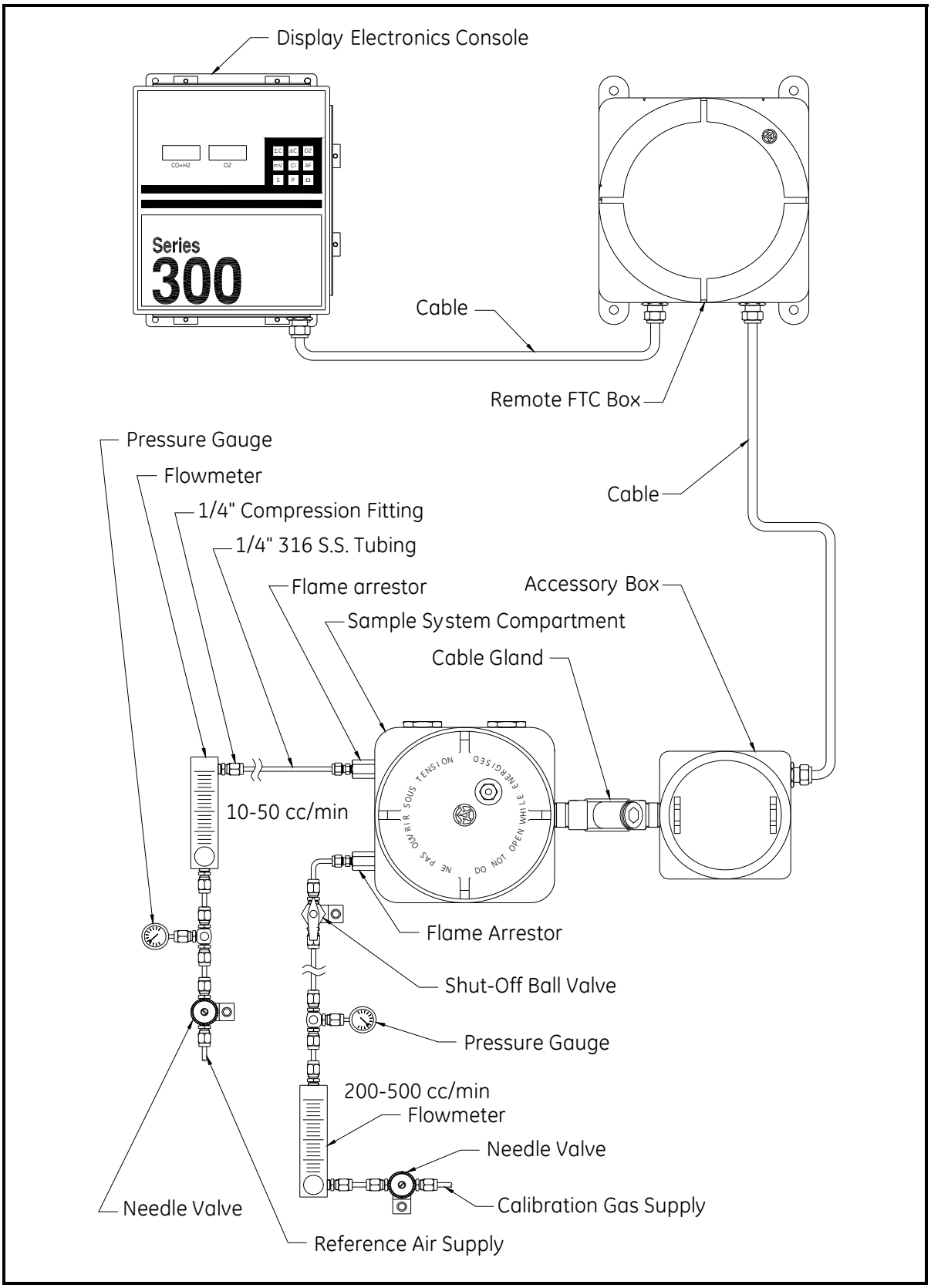

Figure 24: A Complete Explosion-Proof FGA 300 System

Chapter 3. Operation

3.1 Overview

The FGA 300H(X) is an easily operated monitoring device. However, before using the analyzer, allow it to warm-up for at least one hour (three hours if possible). In addition, make sure all electrical and mechanical connections have been completed before power is applied. This chapter includes discussions of the following topics:

- Preventing Common Problems
- Powering Up the System
- Taking Measurements
- Using the Display and Keypad

Calibration of the analyzer should be checked once or twice a week for the first month of operation and then once every two or three months. Units with combustibles detectors need more frequent checking than those with oxygen sensors only. See Chapter 4, *Calibration*, for the correct procedures.

WARNING! **To ensure safe operation of the FGA 300H(X), it must be installed and operated as described in this manual. In addition, be sure to follow all applicable local safety codes and regulations for installing electrical equipment.**

3.2 Preventing Common Problems

Because of the complex techniques required to monitor flue gases, some basic precautions must be observed. Failure to observe these simple procedures is often the cause of some common problems with the FGA 300H(X) operation. Compliance with the following instructions will help to eliminate such problems:

1. Never use thread sealant on any joints in the sample flow path. Thread sealant gives off combustible vapors that can cause reading errors.
2. Do not handle the oxygen sensor or combustibles detector with bare hands. Although some scratches on the platinum coating can be tolerated, rubbing the coating should be avoided.
3. Scrubbing an oxygen sensor or washing a hot sensor in cold water can damage or destroy it. Clean a sensor only by rinsing it with clean water, after the sensor has cooled.
4. Installing a cold probe and/or probe sleeve into a hot manifold can cause these components to seize in the manifold. All fittings should be cool when installing them into the unit.

3.3 Powering Up the System

After checking the wiring connections, apply power to the analyzer. The FGA 300H(X) does not have its own ON/OFF switch. Thus, power is applied to the unit as soon as the external disconnect device is energized. Allow the analyzer to warm up for at least one hour (three hours if possible), before taking measurements.

WARNING! **To prevent corrosion, the analyzer must be powered up immediately after installation. If the analyzer is left installed without power, the unit's components become susceptible to acid condensation that will cause corrosion.**

If the power must be removed for more than thirty minutes, purge the analyzer through the calibration port with a continuous flow of instrument air at a minimum rate of 150 cc/min (0.3 SCFH).

IMPORTANT: *For compliance with the European Union's Low Voltage Directive (73/23/EEC), the standard 300H requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit. Because the sensor furnace power feed in the remote FTC Box must also be interrupted, a 4-pole disconnect device is required. This does not apply to the flameproof 300HX.*

3.4 Taking Measurements

Allow the FGA 300H(X) to warm up sufficiently before taking any measurements. Readings are outputted to the Display Console in percent oxygen (or other ordered parameter) and/or ppm_V combustibles. Other parameters can be displayed using the keypad.

If the Display Console is not included in the system, use the graph in Appendix C, *The Nernst Equation*, to convert the analog output reading into percent oxygen. For a more precise mV to % oxygen conversion, use the following formula:

$$E_{700}\ (\text{mV}) = 48.273 \times \log\left\{\frac{20.9}{\%\ \text{O2 in Sample Gas}}\right\} \qquad (1)$$

Note: *See Appendix C, The Nernst Equation, for more details on how to perform similar calculations at other operating temperatures.*

Although percent oxygen can still be measured without the Display Console, the measurement of combustibles can **NOT** be accomplished without the Display Console.

3.5 Using the Display and Keypad

The front panel of the Display Console shows both the oxygen reading and the combustibles reading (when applicable). The combustibles display shows total combustibles, which is normally a combination of CO and H_2. The oxygen display is factory set to show the ordered parameter. However, the keypad may be used to display all other available parameters, which are listed in Table 9 along with their corresponding keys.

All of the parameters listed in Table 9 can be displayed by pressing the appropriate key on the keypad. The selected parameter is displayed until the key is released.

Note: *These parameters may be selected as the default display using the internal rotary switch (S2). See Chapter 2,* Installation, *for more details.*

Table 9: FGA 300H(X) Keypad Parameters

Key	Parameter	Description
ΣC	Equivalent Combustibles	This parameter, with respect to the total flue gas volume, supplements the combustibles measurement in excess fuel situations.
ΔC	Excess Fuel	This parameter, with respect to fuel only, detects poor combustion or controls conditions when fuel is deliberately in excess, such as in reducing atmospheres.
O_2	Percent Oxygen	This key displays the amount of oxygen in excess of the stoichiometric quantity. This is the only accurate method for properly setting the air/fuel ratio.
mV	Oxygen Sensor Millivolts	This key displays the raw oxygen sensor millivolt output, which indicates the condition of the oxygen sensor.
C.I.	Combustibility Index	This parameter indicates the combustion air requirement index [$CI = 14.02 - (0.67) \times (\%O_2)$].
A.F.	Air Factor	This parameter indicates the proportion of air supplied for stoichiometric combustion. Air factor is often the preferred parameter to control furnaces that are operating from reducing through oxidizing conditions.
S	Not Used	Not Used
P	Not Used	Not Used
Ω	Oxygen Sensor Test	This key tests the operating condition of the sensor and warns in advance that sensor replacement is necessary.

[no content intended for this page]

Chapter 4. Calibration

4.1 Overview

Generally, changes in calibration result from sensor/detector aging. Within limits, reading errors can usually be compensated for by making minor calibration adjustments.

The oxygen sensor should be calibrated every three months, and the combustibles detector should be calibrated upon power up and once a month thereafter. Since the oxygen sensor and combustibles detector are calibrated differently, be sure to proceed to the appropriate section to perform the calibration properly.

WARNING! **To ensure safe operation of the FGA 300H(X), it must be installed and operated as described in this manual. In addition, be sure to follow all applicable local safety codes and regulations for installing electrical equipment.**

All procedures should be performed by trained service personnel.

4.2 Recommended Calibration Gases

To properly calibrate the oxygen sensor and combustibles detector, a calibration gas of known composition must be used. The following calibration gases are recommended by GE:

1. **5% O_2 + 95% N_2:**
   - **a.** calibration gas for oxygen sensor (all ranges)
   - **b.** zero gas for combustibles
   - **c.** this gas should read 30.0 mV at 700°C (1,292°F)

Note: *This gas must be combustibles free, even if the analyzer is not fitted with a combustibles detector.*

2. **1000 ppm_v CO + 500 ppm_v H_2 + 1% O2 + Balance N_2:**
   - **a.** range gas for combustibles
   - **b.** this mixture should read 1500 ppm_v combustibles

Note: *The presence of the 1500 ppm_v combustibles will cause the O_2 to read low by 750 ppm_v.*

IMPORTANT: *A calibration gas containing only CO is not recom-mended, since the analyzer will not respond correctly to dry calibration gases that do not contain H_2.*

4.2 Recommended Calibration Gases (cont.)

IMPORTANT: *The gas cylinders must be certified as to the exact composition of the calibration gas.*

The uncertainty in the oxygen content of the calibration gas is the largest source of error in the calibration process. A standard certificate of analysis has an uncertainty in the smaller component of ±5%. For the oxygen calibration gas, this means an oxygen range of 4.75–5.25%, and the corresponding potential calibration errors shown in Table 10 are introduced.

Table 10: Calibration Uncertainty

$\%O_2$	T(°C)	mV	ΔmV	%Error
4.75	700	31.06	+1.07	+3.57
5.00		29.99	0.00	0.00
5.25		28.96	–1.03	–3.43

As shown in Table 10, a calibration uncertainty of about ±3.5% is introduced by the calibration gas uncertainty alone.

4.3 Calibrating the Oxygen Sensor

To calibrate the oxygen sensor, introduce the chosen calibration gas through the sample system. However, because the sensors can be cooled by a high flow rate, the flow rate of the calibration gas must be regulated. After the calibration gas flow rate is adjusted to the proper value, a calibration check can be performed.

4.3.1 Regulating the Calibration Gas Flow

A temporary connection is usually made for calibration. A blank (plug) is supplied with the FGA 300H(X) to seal the calibration gas inlet when not in use. However, if a permanent connection is preferred, it should be as short as possible with an isolation valve right at the calibration gas inlet on the analyzer.

Each analyzer is tagged with its optimum calibration gas flow rate, based on the analyzer and sampling probe/sleeve combination. Typically, this value will be 220-240 cc/min (0.4-0.5 SCFH).

To set up for calibration complete the following steps:

1. Remove the blank (plug) from the calibration gas inlet port. Refer to Figure 25 on page 46 for the location of the calibration inlet port on the Main Analyzer Unit.
2. Connect the calibration gas and a flowmeter to the calibration gas inlet port. If the calibration gas supply does not come with its own regulator, a needle valve will also need to be installed.
3. Using the flowmeter and the regulator (or needle valve), set the calibration gas flow rate to the tagged value.

If the analyzer does not respond correctly at the tagged calibration gas flow rate (i.e. the oxygen sensor millivolt output reading is more than 5% in error), the problem is probably due to improper siting of the unit. Contact your GE representative for recommendations and/or additional hardware.

CAUTION! **Make sure the calibration gas flow rate does not exceed 500 cc/min (1.0 SCFH). Higher flow rates may cool the oxygen sensor below the normal operating temperature and affect the accuracy of measurements or even cause damage to the oxygen sensor.**

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

4.3.1 Regulating the Calibration Gas Flow Rate (cont.)

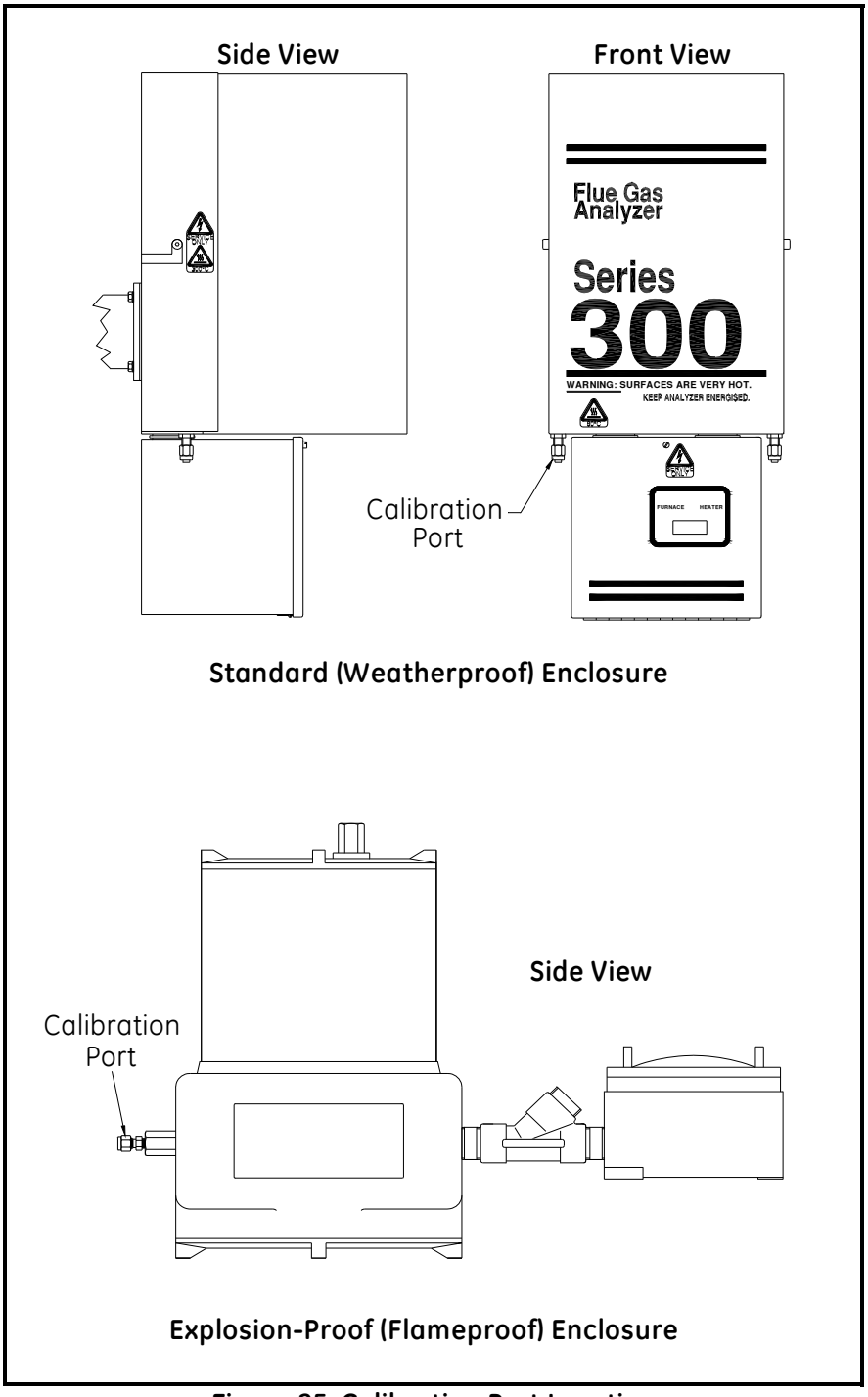

Figure 25: Calibration Port Location

4.3.2 Calibration Check

A calibration check is started by introducing the calibration gas to the oxygen sensor. GE recommends using a calibration gas consisting of 5% O_2 and 95% N_2, as described on page 43.

Note: *Explosion-proof (flameproof) analyzers require a constant 10–50 cc/min air flow into the reference air purge connection.The idea is to maintain a flow rate that is high enough to be verifiable but not so high as to create a backpressure greater than 1 psi.*

To calibrate the oxygen sensor, complete the following steps:

1. Introduce a calibration gas mixture, containing a known amount of oxygen, at the tagged flow rate to the Main Analyzer Unit. Refer to Figure 25 on page 46 for the location of the calibration gas inlet port.
2. Read the voltage in one of three places:
   - press the mV key on the Display Console keypad (if one is included in the system), or using a voltmeter,
   - measure across pins 1 and 2 on terminal block TB1 in the Remote FTC Box, or
   - measure across pins 1 and 2 on terminal block TB1 in the Accessory Box.

See Figure 26 on page 48 for the location of the terminal blocks.

When using the recommended calibration gas (5% O_2 + 95% N_2), the oxygen sensor output voltage should be **29.99 ±0.2 mV at 700°C**. For other gas mixtures, calculate the expected oxygen sensor voltage output with the following equation:

$$E_{700}\ (\text{mV}) = 48.273 \times \log\left\{\frac{20.9}{\%\ \text{O2 in Cal. Gas}}\right\} \qquad (2)$$

Note: *For a FGA 300H(X) operating at any other temperature, refer to Appendix C,* The Nernst Equation, *for details on converting the known oxygen concentration into the expected oxygen sensor millivolt output reading.*

4.3.2 Calibration Check (cont.)

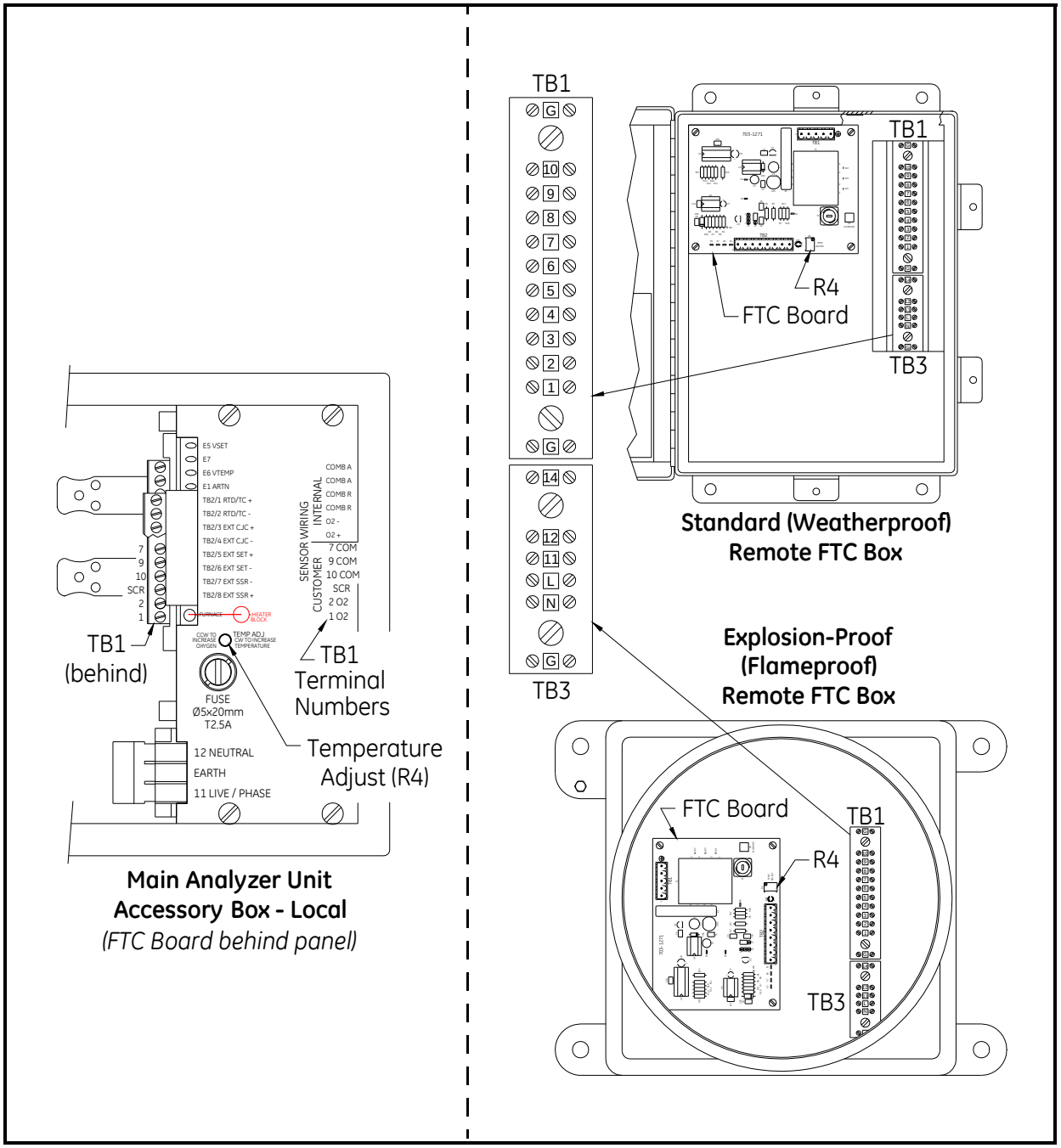

Figure 26: FTC Board (R4) and TB1 Locations

4.3.2 Calibration Check (cont.)

If necessary, adjust the sensor furnace *operating temperature* using potentiometer R4 on the FTC printed circuit board in the following manner (see Figure 26 on page 48 for the location of R4):

Note: *For units fitted with previous versions of the FTC circuit board, the location and designation of the temperature adjustment potentiometer is different. Refer to Appendix F,* Previous Configurations*, for the correct information.*

- Turn R4 clockwise to increase the sensor furnace temperature and reduce the percent oxygen reading, or
- Turn R4 counterclockwise to reduce the sensor furnace temperature and increase the percent oxygen reading.

Each 360° turn of potentiometer R4 will change the reading by about 0.15% oxygen (assuming an oxygen level of about 5%), which equates to about 3% of the full scale setting. Due to thermal inertia of the sensor furnace, the change in output will not immediately follow the change made to R4. Therefore, make the adjustments in small increments and allow several minutes for each new reading to stabilize.

IMPORTANT: *According to the Nernst equation, a 5% error in the mV output reading from the oxygen sensor would require a temperature adjustment of approximately 50°C. As the FTC setting is unlikely to be the source of such a large error, if the measurement error is greater than 5% of the reading, contact the factory for assistance in tracing the source of the problem.*

4.4 Calibrating the Combustibles Detector

In order to properly calibrate the combustibles detector, the following three steps must be performed:

- check the operating temperature of the combustibles detector
- perform a zero check
- perform a span check

4.4.1 Checking the Operating Temperature

Before beginning the calibration, the operating temperature of the combustibles detector should be checked. The operating temperature of the combustibles detector is controlled by the cartridge heaters in the heater block. The heaters maintain the combustibles detector at a steady temperature, to ensure consistent measurements. Do not proceed with the calibration if the operating temperature is incorrect. At the normal operating temperature of 225°C (437°F), the resistance of the combustibles detector's active and reference elements should measure between 1800 and 1900 ohms. Furthermore, the resistances of the two elements should be within 50 ohms of each other, while reading the sample gas. If these conditions are not met, consult the factory for assistance.

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

The resistances are checked on pins 5–7 of terminal block TB1 in the Display Console. See Figure 27 on page 51 for the location of TB1 and the calibration potentiometers. To check the resistances, complete the following steps:

1. Disconnect the wire from pin 6 of terminal block TB1.
2. Attach one lead of a multimeter to the disconnected pin 6 wire.
3. Attach the other lead of the multimeter to pin 5 of terminal block TB1 and record the resistance value.
4. Move the multimeter lead from pin 5 to pin 7 of terminal block TB1 and record the resistance value.
5. Both readings should be between 1800 and 1900 ohms, and the difference between them should not exceed 50 ohms. If this is not the case, contact the factory for assistance.
6. Disconnect the multimeter and immediately reconnect the wire to pin 6 of terminal block TB1.

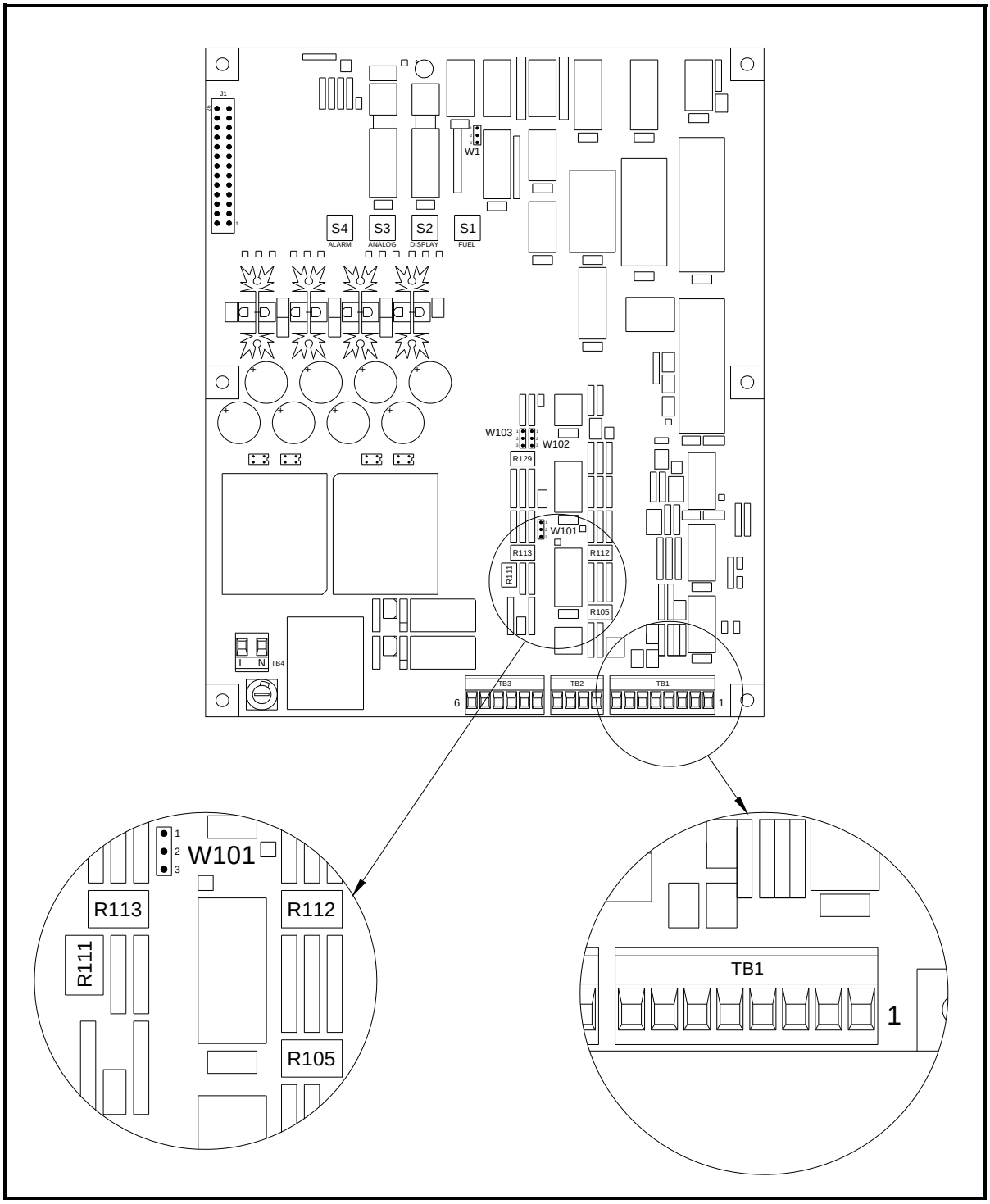

Figure 27: Display Console Circuit Board

Note: *For units fitted with the previous version of the 300D printed circuit board, see Appendix F,* Previous Configurations, *for the layout of this circuit board.*

4.4.2 Zero Check

To perform a zero check, complete the following steps:

Note: *See Figure 25 on page 46 for the location of the calibration gas port and refer to* "Regulating the Calibration Gas Flow Rate" *on page 45 for the correct flow rate.*

1. Introduce the zero combustibles gas into the calibration gas inlet port on the Main Analyzer Unit. The oxygen span gas, which consists of 5% O_2 and 95% N_2, may also be used for the zero combustibles gas. This reduces the number of gas cylinders required to calibrate the analyzer and the two adjustments may be made simultaneously.
2. Verify that the 300D Display reads 0 ppm_V.

If the 300D Display does not read 0 ppm_V, adjust the trimmer potentiometer R111 on the 300D Display printed circuit board. Since R111 is very sensitive, adjustments should be made in small increments. Refer to Figure 27 on page 51 for the location of R111, and adjust it in the appropriate direction:

- Turn R111 clockwise to increase the ppm_V reading, or
- Turn R111 counterclockwise to reduce the ppm_V reading.

If the 300D Display can not be adjusted to read 0 ppm_V, the combustibles detector must be replaced.

4.4.3 Span Check

To perform a span check, complete the following steps:

1. Introduce the span calibration gas. A span calibration gas consisting of 1000 ppm_V CO + 500 ppm_V H_2 + 1% O_2 + balance N_2 is recommended.
2. The combustibles reading should be approximately 1500 ppm_V for the gas specified in the previous step.

Note: *During this procedure, the oxygen reading will be low because the oxygen sensor measures* excess *oxygen and the combustion of the span calibration gas consumes 750 ppm_V of the oxygen.*

If the reading is incorrect, adjust trimmer potentiometer R105 on the 300D Display printed circuit board. This adjustment is not as sensitive as the zero adjustment with R111, and the R105 adjustments may be made in larger increments. Refer to Figure 27 on page 51 for the location of R105, and adjust it in the appropriate direction:

- Turn R105 clockwise to increase the ppm_V reading, or
- Turn R105 counterclockwise to reduce the ppm_V reading.

This completes the calibration of the combustibles detector.

Chapter 5. Troubleshooting

5.1 Overview

The FGA 300H(X) has been designed to overcome most of the problems commonly associated with monitoring flue gases. However, because of the corrosive and extreme conditions under which the instrument must operate, some difficulties may still be encountered. The procedures for resolving many of these situations are discussed in this chapter. If the information provided in this chapter is not sufficient, please consult the factory for assistance.

The FGA 300H(X) analyzer has two sets of error indicators that can occur:

- oxygen measurement errors
- combustibles measurement errors

Each error indicator appears on the corresponding readout of the 300D Display Console. Thus, if there is an oxygen measurement error, the error indicator will appear on the oxygen readout.

Refer to Table 11 on page 54 to troubleshoot the FGA 300H(X) analyzer.

WARNING! **To ensure safe operation of the FGA 300H(X), it must be installed and operated as described in this manual. In addition, be sure to follow all applicable local safety codes and regulations for installing electrical equipment.**

All procedures should be performed by trained service personnel.

Table 11: Troubleshooting Guide

Error Indicator	System Response	Description	Go To:
Possible Oxygen Error Indicators			
Blinking "--.--" * (error code E1)	1. alarm relay activated 2. analog output shows a lack of oxygen on all ranges 3. stoichiometric interlock is activated	1. sensor signal exceeds full scale input (1000 mV) 2. possible open circuit 3. possible cold furnace	page 55
"PP.PP" and Normal Reading Alternate	alarm relay activated	the sensor signal has not changed in 15 minutes - the probe may be plugged	page 65
Blinking Reading	no response	sensor impedance is high - the sensor may need replacement	page 65
Oxygen Concentration Reads Constant 20.9%	no response	1. sensor or its wiring shorted 2. severe air leak (i.e. cal. port open, sample system not sealed, etc.)	page 67
Oxygen Reading Above 20.9% (error code E4 or reading of 55.35)	no response	sensor wiring reversed	page 69
Oxygen Reading Too Low	no response	1. combustibles in the sample 2. sensor out of calibration	page 69
Oxygen Reading Too High	no response	1. poor quality reference air 2. air leak 3. sensor too cold 4. high sample pressure	page 70
Possible Combustibles Error Indicators			
"1 0" Out-Of-Range Indicator	alarms activated	combustibles level is greater than 20,000 ppm_V	page 71
"–12340" Negative Reading	no response	1. combustibles channel is out of calibration 2. wiring of element reversed	page 72
"-1 0" Negative Out- Of-Range Indicator	no response	1. reference element open or active element shorted 2. combustibles channel severely out of calibration 3. detector incorrectly wired	page 73
Low Combustibles Reading, but Correct Oxygen Reading	no response	1. detector physically damaged or improperly installed 2. detector aging 3. calibration flow too low	page 74
* a "1 0" error indicator also appears on the combustibles display (see first O_2 error)			

5.2 Oxygen Errors

This section discusses each of the possible oxygen errors listed in Table 11 on page 54. If an error other than those listed should occur, contact the factory for assistance.

5.2.1 Blinking "--.--"

An oxygen display that alternates between a blank screen and a "--.--" reading indicates an open circuit error and can be caused by one of the following conditions:

Note: *Before proceeding, make sure the unit is not still warming up. This condition may also be indicated by an* `E1` *error code.*

- faulty wiring
- faulty oxygen sensor
- faulty RTD/TC temperature sensor
- faulty sensor furnace
- faulty furnace temperature control (FTC) board

When the FGA 300H(X) detects this error:

- alarms are activated
- analog outputs indicate a lack of oxygen on all ranges
- the stoichiometric interlock is activated, which produces a "1 0" reading on the combustibles display.

To correct this error, refer to the flow diagram in Figure 28 on page 56 and perform the following checks in the order given.

5.2.1a Check the Wiring

The most common reason for the open circuit error is incorrect or loose wiring. Complete the two checks listed below to correct any wiring problems.

WARNING! Be careful when tightening the terminal block electrical connections. Full line voltage is present on some terminals in the Main Analyzer Unit, the FTC Box and the Display Console.

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

5.2.1a Check the Wiring (cont.)

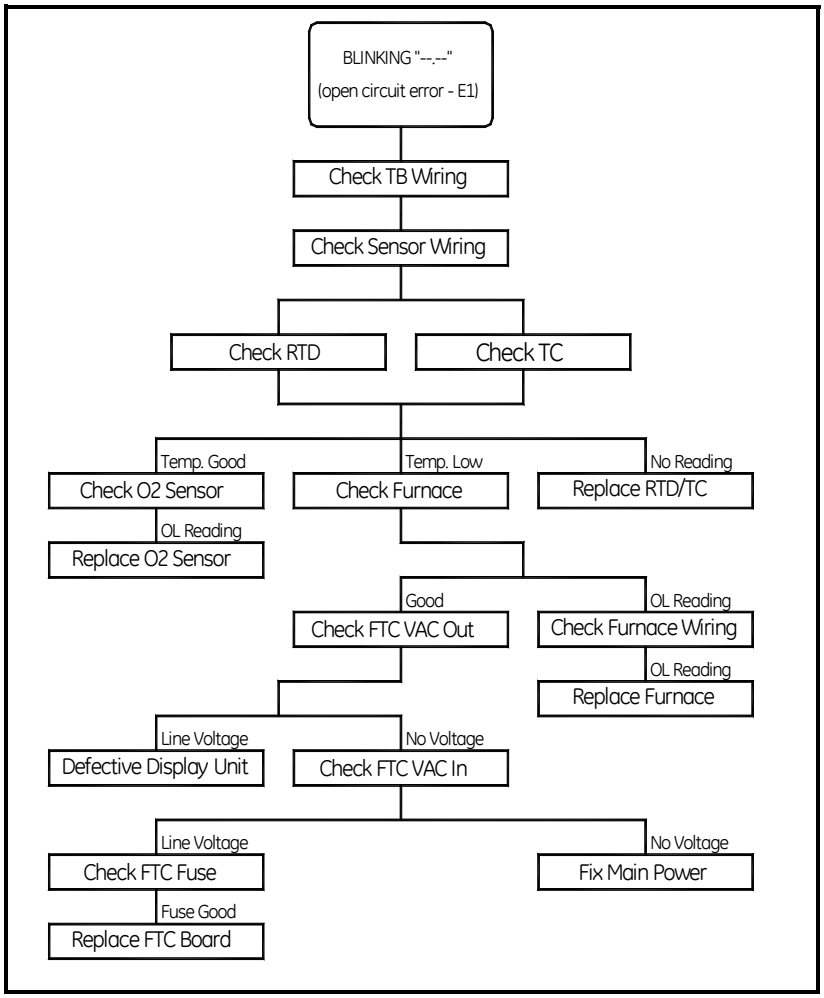

Figure 28: Blinking "--.--" Flow Diagram

1. Check all wiring, including the factory wiring, on the terminal blocks in the Main Analyzer Unit, remote FTC Box, and Display Console. Refer to the wiring instructions in Chapter 2, *Installation*, to make sure that all wires are attached to the correct pins. If any connections are loose, turn the screws clockwise with a small screwdriver to secure the connections.

2. Locate the oxygen sensor clips (see Figure 29 on page 57, which shows the sample system with the analyzer enclosure removed) and short them together with a jumper. The oxygen display should read 20.90% (or 0 mV by pressing the mV key).

If the wiring is good and a 20.90% oxygen reading is obtained with the shorted clips, **remove the jumper** and proceed to the sensor furnace temperature check.

Note: *If an open loop (OL) is measured at the oxygen sensor clips, recheck the wiring and try again. If the OL reading repeats, contact the factory for assistance.*

5.2.1a Check the Wiring (cont.)

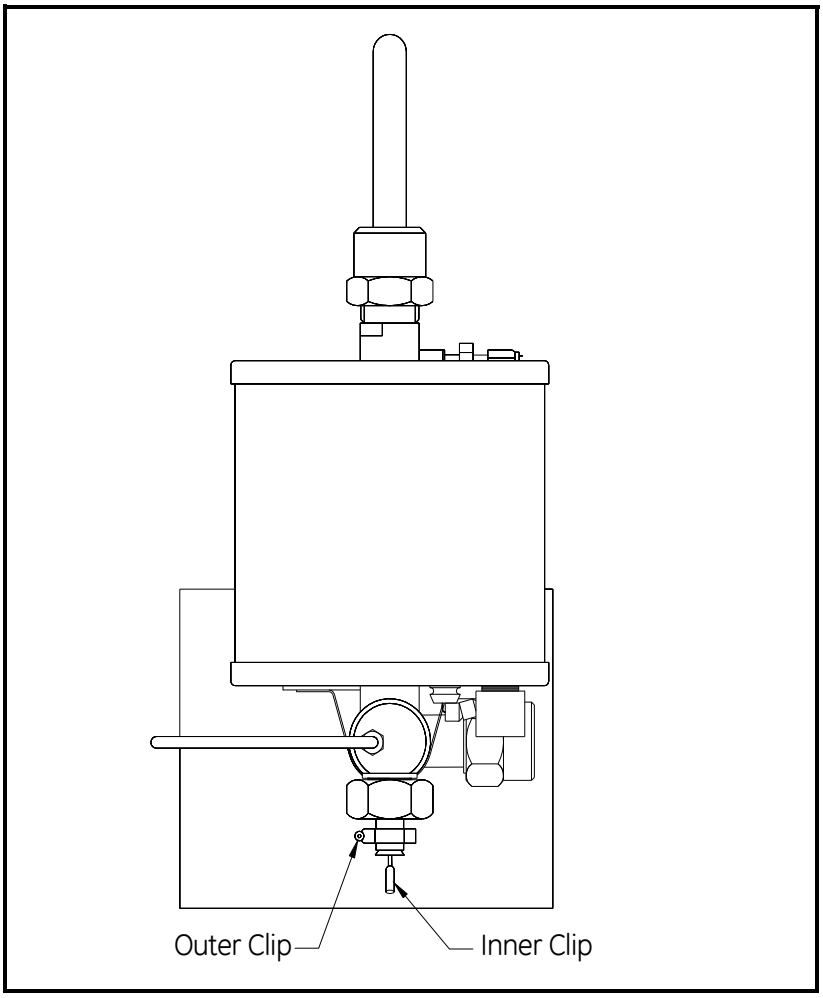

Figure 29: Oxygen Sensor Clips

5.2.1b Check the Temperature Sensor

If the FGA 300H(X) is fitted with an **RTD** temperature sensor, complete **Step 1**. If the FGA 300H(X) is fitted with an optional thermocouple (**TC**) temperature sensor, skip to **Step 2**.

WARNING! There are very hot surfaces in the Main Analyzer Unit. Touching any of these surfaces without heat resistant gloves will result in serious burns.

1. Disconnect the Main Analyzer Unit RTD leads from pins 3 and 4 of terminal block TB1 in the Remote FTC Box.

a. Using a digital multimeter, measure the resistance across the disconnected RTD leads. One of the conditions listed in Table 12 on page 58 should occur.

5.2.1b Check the Temperature Sensor (cont.)

Table 12: RTD Resistance Readings

Resistance Reading	Recommended Action
360-370 ohms	The temperature is good - proceed to the oxygen sensor check.
less than 360 ohms	The temperature is low - proceed to the sensor furnace check.
open loop (OL)	The RTD is defective and must be replaced - see Chapter 6, *Parts Replacement*.

b. Complete the action recommended in Table 12.

Note: *If a resistance reading other than those listed above is obtained, refer to Table 13 to determine the operating temperature of the sensor furnace. A standard FGA 300H(X) operates at a temperature of 700°C.*

Table 13: RTD Resistance vs. Temperature

Resistance vs. Temperature for 100Ω Platinum RTD Sensor

Example:
An RTD resistance of 200 ohms indicates a sensor furnace operating temperature of about 270°C: First, find the resistance value in the table (201.30) that best matches the measure d value. Then, add the values of the column label (200) and the row label (70) together to determine the operating temperature of the sensor furnace (270).

	0	100	200	300	400	500	600	700	800
0	100.00	138.50	175.84	212.03	247.06	280.93	313.65	345.21	375.61
10	103.90	142.28	179.51	215.58	250.50	284.26	316.86	348.30	378.59
20	107.79	146.06	183.17	219.13	253.93	287.57	320.05	351.38	381.55
30	112.16	149.82	186.82	222.69	257.34	290.87	323.24	354.45	384.50
40	115.54	153.57	190.46	226.18	260.50	294.16	326.41	357.51	387.45
50	119.40	157.32	194.08	229.69	264.14	297.43	329.57	360.55	390.38
60	123.24	161.04	197.70	233.19	267.52	300.70	332.72	363.59	------
70	127.07	164.76	201.30	236.67	270.89	303.95	335.86	366.61	------
80	130.89	168.47	204.88	240.15	274.25	307.20	338.99	369.62	------
90	134.70	172.16	208.46	243.61	277.60	310.43	342.10	372.62	------
100	138.50	175.84	212.03	247.06	280.93	313.65	345.21	375.61	------
Ω/°C	0.385	0.373	0.361	0.350	0.338	0.327	0.315	0.304	0.295

5.2.1b Check the Temperature Sensor (cont.)

2. Locate the Main Analyzer Unit TC leads at pins 3 and 4 of terminal block TB1 in the Remote FTC Box.

a. Using a digital multimeter, measure the voltage across the TC terminals. One of the conditions listed in Table 14 should occur.

Table 14: Thermocouple Voltage Readings

Voltage Reading	Recommended Action
30-32 mV (700°C)	The temperature is good - proceed to the oxygen sensor check.
less than 29 mV	The temperature is low - proceed to the sensor furnace check.
0 mV	The TC is defective and must be replaced - see Chapter 6, *Parts Replacement*.

b. Complete the action recommended in Table 14.

Note: *If a voltage reading other than those listed above is obtained, refer to Figure 30 or Table 15 on page 60 to determine the operating temperature of the sensor furnace. A standard FGA 300H(X) operates at a temperature of 700°C.*

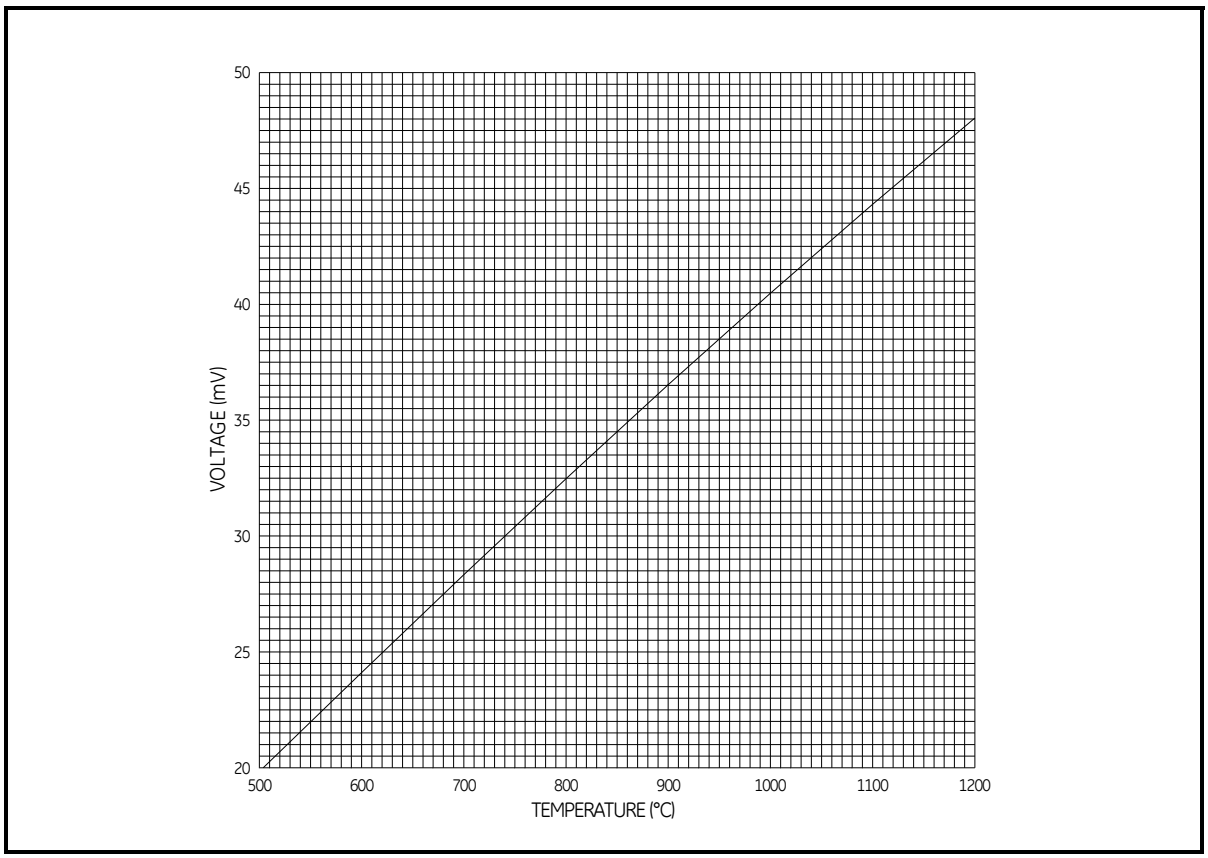

Figure 30: Thermocouple Voltage vs. Temperature

5.2.1b Check the Temperature Sensor (cont.)

Table 15: Thermocouple Voltage vs. Temperature

Temp.(°C)	E(mV)	Temp.(°C)	E(mV)
20	(0.7981)	740	30.0002
500	19.8462	750	30.4153
510	20.2725	760	30.8296
520	20.6990	770	31.2429
530	21.1254	780	31.6553
540	21.5519	790	32.0668
550	21.9783	800	32.4773
560	22.4046	810	32.8868
570	22.8307	812	32.9686
580	23.2565	820	33.2953
590	23.6821	830	33.7029
600	24.1073	840	34.1094
610	24.5322	850	34.5150
620	24.9566	860	34.9196
630	25.3805	870	35.3231
640	25.8039	880	35.7257
650	26.2267	890	36.1272
660	26.6489	900	36.5278
670	27.0705	910	36.9273
680	27.4914	920	37.3259
690	27.9115	930	37.7234
700	28.3309	940	38.1199
710	28.7494	950	38.5154
720	29.1672	960	38.9099
730	29.5841	970	39.3033

5.2.1c Check the Oxygen Sensor

If the sensor furnace operating temperature was within the normal range, the troubleshooting sequence should resume here.

1. Disconnect the Main Analyzer Unit leads from pins 1 and 2 (oxygen sensor connections) of terminal block TB1 in the Remote FTC Box.
2. Using a digital multimeter, measure the resistance between the two oxygen sensor clips. Place the positive lead of the multimeter on the inner clip (the clip inside the base of the oxygen sensor) as close to the oxygen sensor as possible without touching it. Place the negative lead of the multimeter on the outer clip (the clip around the base of the oxygen sensor). See Figure 29 on page 57 for the location of the clips.
3. If the measurement indicates an open loop (OL), adjust the clips to make certain they are making good contact with the oxygen sensor and take another reading. If an open loop is still measured, the oxygen sensor is defective and must be replaced.

5.2.1d Check the Sensor Furnace

If the sensor furnace operating temperature was too low, the troubleshooting sequence should resume here.

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

1. Disconnect the sensor furnace leads from pins 12 and 14 of terminal block TB3 in the Accessory Box.
2. Using a digital multimeter, measure the resistance across the disconnected sensor furnace leads. One of the conditions listed in Table 16 should occur.

Table 16: Sensor Furnace Resistance Readings

Resistance Reading	Recommended Action
63-70 ohms	The sensor furnace is good - proceed to the FTC board check.
open loop (OL)	Check the wires from the Accessory Box to the ceramic block to see if they are broken or loose. If the wiring is good, the sensor furnace is defective and must be replaced (refer to Chapter 6, *Parts Replacement*).

5.2.1d Check the Sensor Furnace (cont.)

3. Reconnect the sensor furnace leads to pins 12 and 14 of terminal block TB3 in the Accessory Box.

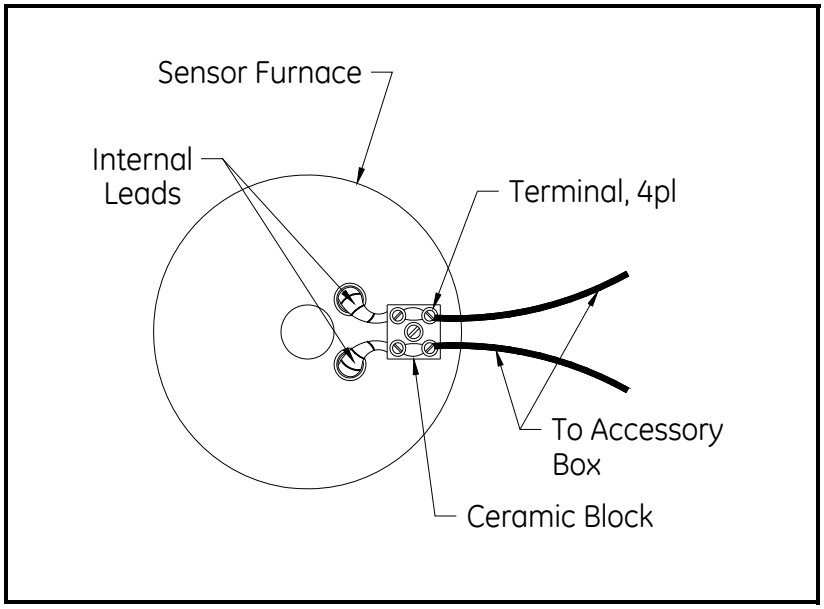

Figure 31: Bottom View of Furnace

Table 17: Sensor Furnace Resistance Readings

Resistance Reading	Recommended Action
66 ohms	There is a bad connection on the ceramic block. Make sure the wires are fed all the way through the ceramic block and exit on the opposite side from which they were inserted. Tighten all four screws and verify continuity across the ceramic block (see Figure 31).
open loop (OL)	Check the wires from the Accessory Box to the ceramic block to see if they are broken or loose. If the wiring is good, the sensor furnace is defective and must be replaced (refer to Chapter 6, *Parts Replacement*).

4. Complete the action recommended in Table 17.

5.2.1e Check the FTC Board

1. Using a digital multimeter, measure the FTC board's AC output voltage to the sensor furnace across pins 12 and 14 on terminal block TB3 in the Remote FTC Box and across pins 3 and 4 of terminal block TB1 on the FTC board. See Figure 32 for the terminal block locations, and record the two voltage readings.

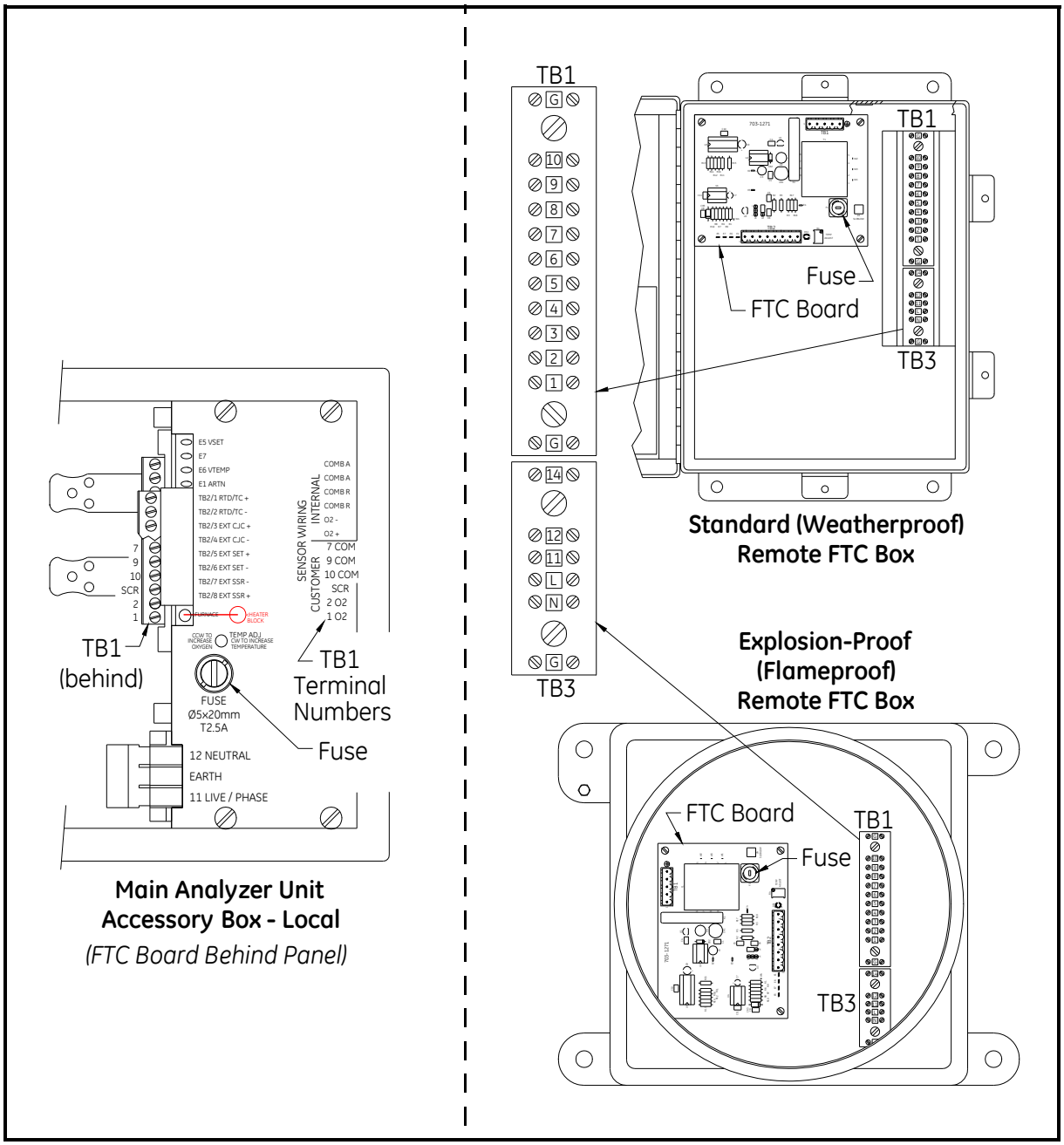

Figure 32: FTC Board (Fuse) and TB1 Locations

5.2.1e Check the FTC Board (cont.)

2. The voltages at the two terminal blocks should be the same. If they are not, check the wiring between the terminal blocks (refer to Chapter 2, *Installation*). Then, one of the conditions listed in Table 18 should occur.

Table 18: FTC Output Voltage Readings

Voltage Reading	Recommended Action
Approximately full line voltage	The FTC board is good. The Display Electronics Console may be defective - contact the factory for assistance.
Voltage greater than 0, but less than full line voltage	The FTC board is defective and must be replaced. See Chapter 6, *Parts Replacement*.
No voltage present	Proceed with the remaining steps in this section.

3. Using a digital multimeter, measure the FTC board's AC input voltage across pins 1 and 2 of terminal block TB1 on the FTC board. See Figure 32 on page 63 for the location of TB1. One of the conditions listed in Table 19 should occur.

Table 19: FTC Output Voltage Readings

Voltage Reading	Recommended Action
Approximately full line voltage	Continue with the next step in this section.
No voltage present	There is no power reaching the FTC box - check the power source.

4. Remove the FTC board fuse (see Figure 32 on page 63) and check it for continuity. If the fuse is blown, replace it with a new fuse of the size and type listed in Chapter 7, *Specifications*.

5. If the FTC board fuse is good, the FTC board is defective and must be replaced. See Chapter 6, *Parts Replacement*, for instructions.

5.2.1 Blinking "--.--" (cont.)

If the instructions provided in this section have not resolved the problem, contact the factory for assistance.

Note: *Older FGA 300H(X) units may have a different FTC board and/or a sensor furnace power transformer. For units so equipped, refer to Appendix F,* Previous Configurations, *for troubleshooting instructions.*

5.2.2 "PP.PP" and Normal Reading Alternate

This oxygen display condition indicates that the signal from the oxygen sensor has changed less than 0.2 mV in 15 minutes. Such a situation can indicate either that the probe is plugged or that the process is unusually stable.

When this error condition occurs:

- the alarm relay is activated
- the analog outputs are not affected

Plugging of the probe usually occurs in very dirty applications. If the problem is a plugged probe, use a blowback system (contact the factory for details) to unplug the analyzer. If the flue gas composition is really that stable, this warning may be ignored.

5.2.3 Blinking Reading

A blinking reading on the oxygen display is usually caused by either of two conditions:

- the oxygen sensor has exceeded its useful lifetime
- the sensor furnace is not at the proper temperature

To correct this condition refer to the flow diagram in Figure 33 on page 66 and perform the following tests:

5.2.3a Check the Oxygen Sensor

Every two hours, the FGA 300H(X) automatically measures the impedance of the oxygen sensor. If the impedance is above the acceptable range, the oxygen display reading blinks. This means the oxygen sensor is aging and should be replaced. To test the oxygen sensor impedance manually, complete the following steps:

1. Press the mV key located on the keypad of the Display Console and record the voltage reading.

2. Simultaneously press the Ω and mV keys, located on the keypad of the Display Console, and record the voltage reading.

3. If the voltage reading from Step 2 is more than 50% the voltage reading from in Step 1, replace the oxygen sensor.

IMPORTANT: *The oxygen sensor will continue to take accurate readings for a while after the* Blinking Reading *error condition occurs, but the oxygen sensor should still be replaced as soon as possible.*

5.2.3b Check the Remaining Components

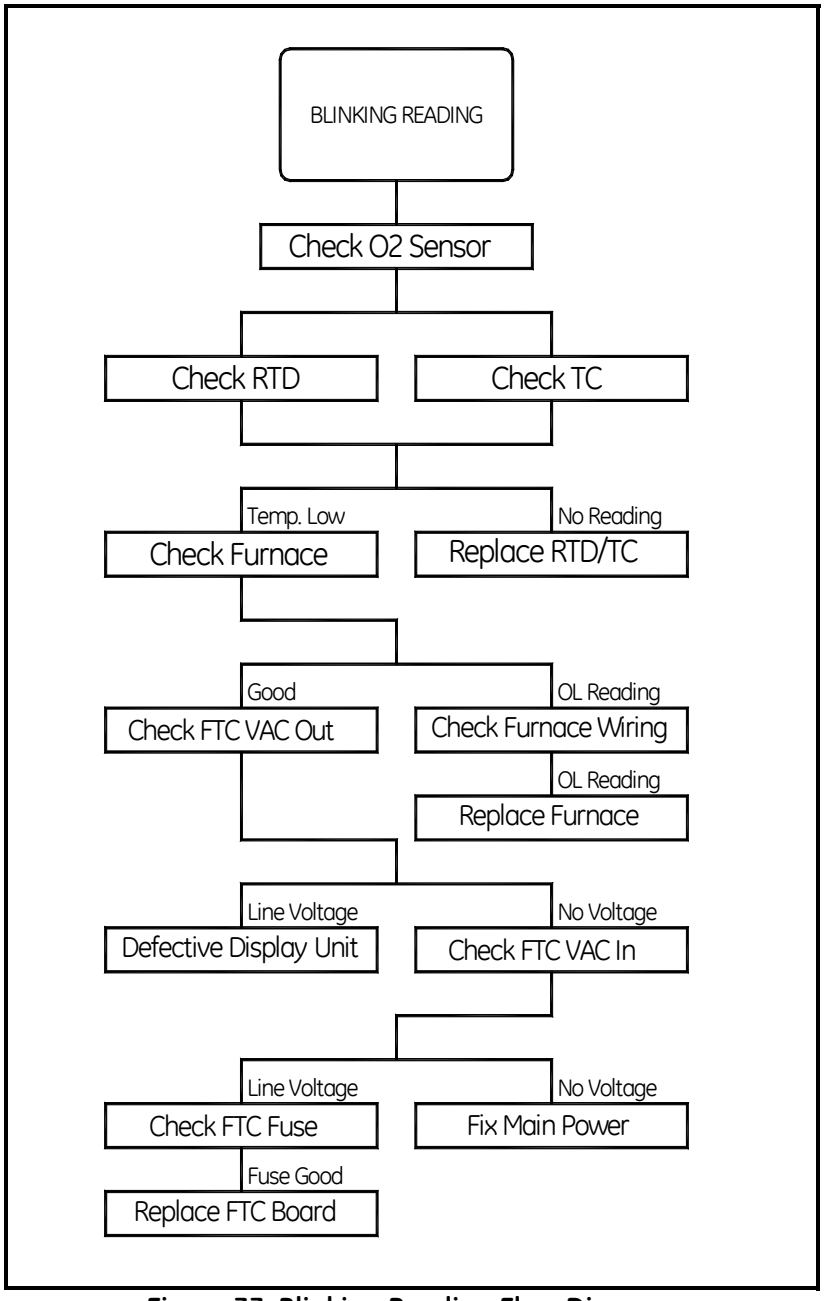

Figure 33: Blinking Reading Flow Diagram

Continue the troubleshooting sequence shown in Figure 33, by completing the steps beginning with the *"Check the Temperature Sensor"* section on page 57.

5.2.4 Oxygen Concentration Reads Constant 20.9%

This condition is unusual and is likely to be caused either by a short in the oxygen sensor wiring, a severe air leak in the plumbing or a defective Display Console. A brief description of how to remedy this problem is presented below.

WARNING! The main analyzer enclosure is hot. Use heat-resistant gloves when handling the enclosure.

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

5.2.4a Check the Oxygen Sensor Wiring

Refer to Figure 29 on page 57 for the location of the oxygen sensor clips, and check for a short circuit in the contact clip wiring (two wires touching). If this does not correct the problem, proceed to the next section.

5.2.4b Check for Plumbing Leaks

A plumbing leak permits cross-contamination of the reference air and the flue gas sample. Use the following steps to remedy the problem:

1. Make sure that the calibration gas port on the Main Analyzer Unit has not been left open. This would admit atmospheric air into the sample system and force a 20.9% reading.
2. Remove the Sample System Compartment cover and check all sample system plumbing connections for leaks. Make sure that the oxygen sensor and combustibles detector ports are properly sealed.

When the reference air is contaminated by the same gases that are being measured, the oxygen sensor generates a 0.00 mV analog output signal and a 20.9% oxygen reading. Removing the cover permits uncontaminated reference air to enter the unit. If removing the cover and fixing any plumbing leaks does not cause the 20.9% reading to drop, proceed to the next section.

3. If the oxygen reading drops in Step 2 above, ensure that all fittings are tight and replace the Sample System Compartment cover. If the oxygen reading gradually returns to 20.9%, try tightening the fittings an additional 1/8 turn. If the problem persists, contact the factory for assistance.

CAUTION! Do not tighten fittings more than 1/8 turn at a time.

5.2.4c Check the Display Electronics Console

If the shorted wiring and plumbing leak checks have not corrected the problem, complete the following steps:

1. Disconnect the oxygen sensor leads from pins 2 and 3 of terminal block TB1 in the Display Console. See Figure 34 for the location of TB1.

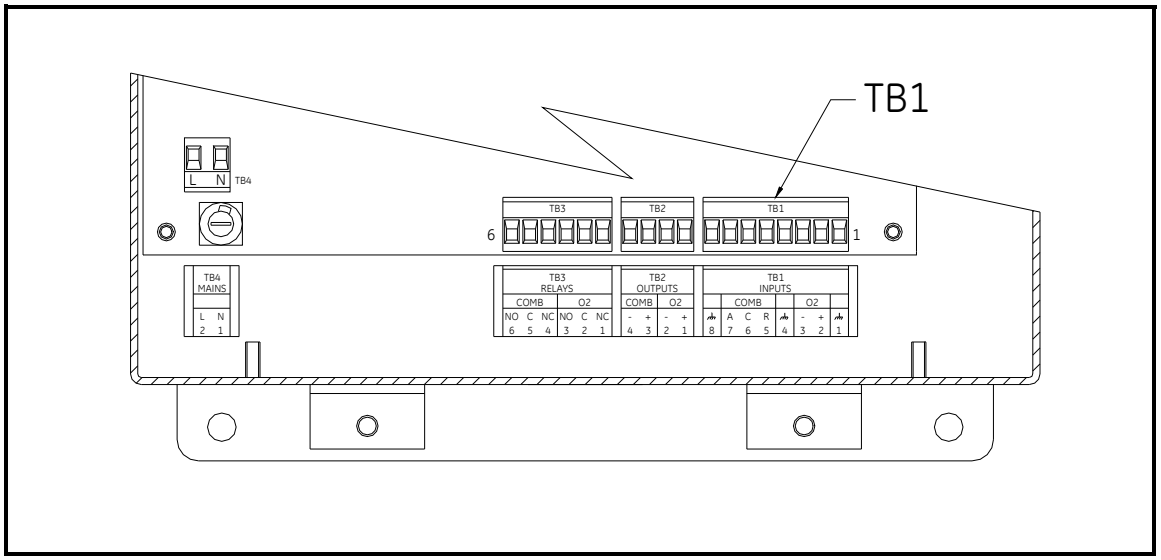

Figure 34: Display Electronics Console - TB1

2. Connect the positive lead of a digital voltmeter to the wire removed from pin 2 and connect the negative voltmeter lead to the wire removed from pin 3.

IMPORTANT: *The oxygen sensor leads must be removed from the terminal block for this test. If the leads are not disconnected, a short on the Display Console circuit board could result in a false 0.00 mV reading.*

3. A voltage reading of 0.00 mV should be obtained, to correspond with the 20.9% oxygen reading. If any voltage other than 0.00 mV is measured, the Display Console is defective. Contact the factory for assistance.

Note: *For units fitted with the previous version of the 300D printed circuit board, see Appendix F,* Previous Configurations*, for the layout of this circuit board.*

5.2.5 Oxygen Reading Above 20.9%

An oxygen display reading greater than 20.9%, which may also be indicated by a display reading of 55.35 or the error code E4, is almost always caused by reversed wiring of the oxygen sensor. For example, 5% oxygen at 700°C would generate an oxygen sensor output of +29.97 mV. However, reversed oxygen sensor wiring would cause this reading to be –29.97 mV. The Nernst equation calculation would then convert this voltage to an oxygen display of 87.36%!

1. To correct this problem, check the oxygen sensor wiring at TB1 in the Accessory Box, TB1 in the remote FTC Box and TB1 in the Display Console for the correct polarity (refer to Chapter 2, *Installation*).

5.2.6 Oxygen Reading Too Low

This condition is usually caused by combustibles in the sample gas, but it may also be the result of the oxygen sensor being out of calibration. To correct the condition, complete the following steps:

1. The sample gas may be contaminated with combustibles from the following two common sources:

- grease or oil in the sensor plumbing
- silicon-based plumbing tape
- excess fuel in the burner

The oxygen sensor will cause combustibles such as CO, H_2, or hydrocarbons in the sample to react with oxygen, thus depleting the oxygen in the sample gas. This will give a reading that may be less than the expected amount of oxygen. To fix the problem, remove the source of the contamination.

2. If the sample gas is not contaminated with hydrocarbons, recalibrate the oxygen sensor. See Chapter 4, *Calibration*, for the correct procedure.

5.2.7 Oxygen Reading Too High

This condition is most likely caused either by poor quality reference air, a leak in the plumbing or an oxygen sensor that is too cool. A brief description of possible solutions to this problem is presented below.

WARNING! The main analyzer enclosure is hot. Use heat-resistant gloves when handling the enclosure.

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

5.2.7a Check for Plumbing Leaks

A plumbing leak permits contamination of the reference air by the flue gas sample. The resulting reduction in the ratio of the oxygen partial pressures reduces the mV output from the oxygen sensor and yields a percent oxygen reading that is higher than expected. Use the following steps to remedy the problem:

1. Remove the Sample System Compartment cover, in order to allow uncontaminated reference air to enter the unit.
2. If the oxygen reading drops in Step 1 above, tighten all fittings by 1/8 turn and replace the Sample System Compartment cover. If the oxygen reading gradually increases, repeat Step 1.

CAUTION! Do not tighten fittings more than 1/8 turn at a time.

5.2.7b Check the Oxygen Sensor Temperature

If the oxygen sensor is below its normal operating temperature, the mV output will be too low and the percent oxygen reading will be higher than expected. Proceed as follows:

1. The easiest way to check the sensor temperature is to calibrate the oxygen sensor as described in Chapter 4, *Calibration*. The calibration procedure includes instructions for adjusting the sensor furnace temperature, if necessary.

If the problem has not been resolved by the steps in this section, contact the factory for assistance.

Note: *Although the E2 (sensor aging) and E3 (probe plugging) error codes have been defined, they have not yet been implemented.*

5.3 Combustibles Errors

The following is a list of the possible combustibles error indicators. If an unlisted error occurs, contact the factory for assistance.

5.3.1 "1 0" Out-Of-Range Indicator

The out-of-range error indicator is usually caused by one of the following conditions:

- the stoichiometric interlock is activated
- faulty combustibles detector or wiring
- combustibles channel is out of calibration.
- insufficient excess oxygen to support burning of the combustibles
- combustibles level is greater than 19,990 ppm_V

To correct this error, perform the following checks until the problem is remedied:

5.3.1a Check Oxygen Channel

The "1 0" combustibles error indicator can be caused by the detection of an open circuit in the oxygen channel, which activates the stoichiometric interlock. If a blinking "--.--" error indicator also appears on the oxygen display, refer to the *Blinking "--.--"* section on page 55 to correct both of these errors. If the error is not oxygen related, proceed to the next section.

5.3.1b Check the Combustibles Detector

The out-of-range combustibles error may also be caused by a faulty or incorrectly wired combustibles detector. To check this possibility, complete the following steps:

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

1. Refer to Chapter 2, *Installation*, and verify that the combustibles detector is correctly wired at terminal blocks TB1 in the Accessory Box, the remote FTC Box and the Display Console. Make sure that none of the wires interconnecting the three terminal blocks are loose or broken.
2. In the Accessory Box, disconnect the common wire from pin 9 of terminal block TB1, and attach one lead of a multimeter to the disconnected wire.
3. Attach the other lead of the multimeter to pin 10 of terminal block TB1 and record the resistance of the reference element.

5.3.1b Check the Combustibles Detector (cont.)

4. Move the multimeter lead from pin 10 to pin 7 of terminal block TB1 and record the resistance of the active element.

5. Both readings should be between 1800 and 1900 ohms, and the difference between them should not exceed 50 ohms. Disconnect the multimeter and reconnect the common wire to pin 9 of terminal block TB1. If the proper readings were obtained, skip to the next section.

6. If either element is shorted (0 ohms) or open (OL), the combustibles detector is defective and must be replaced. See Chapter 6, *Parts Replacement*, for instructions.

7. If the combustibles detector passes the above checks, the combustibles channel may be out of calibration. Refer to Chapter 4, *Calibration*, for instructions on calibrating the combustibles detector.

If the steps in this section do not correct the "1 0" combustibles error, consult the factory for assistance.

5.3.2 "–12340" Negative Reading

A negative reading on the combustibles display can be caused by incorrect wiring of the combustibles detector or the combustibles circuitry being out of calibration. To correct the problem, complete the following steps:

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

1. Refer to Chapter 2, *Installation*, and verify that the combustibles detector is correctly wired at terminal blocks TB1 in the Accessory Box, the remote FTC Box and the Display Console.

2. If the combustibles detector wiring is correct, the combustibles circuitry may be out of calibration. Refer to Chapter 4, *Calibration*, for instructions on calibrating the combustibles detector.

If the steps in this section do not correct the "–12340" combustibles error, consult the factory for assistance.

5.3.3 "-1 0" Negative Out-Of-Range Indicator

The negative out-of-range error indicator is usually caused by one of the following conditions:

- faulty combustibles detector or wiring
- combustibles circuitry is out of calibration.

To correct this error, perform the following checks until the problem is remedied:

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

1. Refer to Chapter 2, *Installation*, and verify that the combustibles detector is correctly wired at terminal blocks TB1 in the Accessory Box, the remote FTC Box and the Display Console. Make sure that none of the wires interconnecting the three terminal blocks are loose or broken.
2. In the Accessory Box, disconnect the common wire from pin 9 of terminal block TB1, and attach one lead of a multimeter to the disconnected wire.
3. Attach the other lead of the multimeter to pin 10 of terminal block TB1 and record the resistance of the reference element.
4. Move the multimeter lead from pin 10 to pin 7 of terminal block TB1 and record the resistance of the active element.
5. Both readings should be between 1800 and 1900 ohms, and the difference between them should not exceed 50 ohms. Disconnect the multimeter and reconnect the common wire to pin 9 of terminal block TB1. If the proper readings were obtained, skip to the next section.
6. If either element is shorted (0 ohms) or open (OL), the combustibles detector is defective and must be replaced. See Chapter 6, *Parts Replacement*, for instructions.
7. If the combustibles detector passes the above checks, the combustibles circuitry may be out of calibration. Refer to Chapter 4, *Calibration*, for instructions on calibrating the combustibles detector.

If the steps in this section do not correct the "-1 0" combustibles error, contact the factory for assistance.

5.3.4 Low Combustibles Reading, but Correct Oxygen Reading

If the *"Low Combustibles Reading"* error condition occurs, check the following possible causes:

- the combustibles detector was improperly installed or is physically damaged
- the combustibles detector has lost sensitivity due to aging
- the combustibles detector was calibrated at too low a flow rate.

To correct this error condition, complete the following steps:

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

1. Remove the cover from the Sample System Compartment and inspect the installation of the combustibles detector. Verify that the serial number label on the detector is in the 9 o'clock position, which indicates that the two elements are positioned with the active element above the reference element. Refer to Chapter 6, *Parts Replacement*, for detailed installation instructions for the combustibles detector.
2. Remove the combustibles detector and inspect the two elements. The active and reference elements should be parallel to each other and approximately 5/32 in. (4 mm) apart. If the elements are too close together, heat will transfer from the active element to the reference element and lower the output signal. If the active element is bent outward, some of its heat may be transferred to the manifold structure and lower the output signal.
3. Reinstall the combustibles detector as described in Chapter 6, *Parts Replacement*. Test the combustibles detector by completing the following steps:
   a. In the Accessory Box, disconnect the common wire from pin 9 of terminal block TB1, and attach one lead of a multimeter to the disconnected wire.
   b. Attach the other lead of the multimeter to pin 10 of terminal block TB1 and record the resistance of the reference element.
   c. Move the multimeter lead from pin 10 to pin 7 of terminal block TB1 and record the resistance of the active element.
   d. Both readings should be between 1800 and 1900 ohms, and the difference between them should not exceed 50 ohms. Disconnect the multimeter and reconnect the common wire to pin 9 of terminal block TB1. If the proper readings are obtained, skip to Step 4 below.
   e. If the resistance readings are outside the acceptable range, the combustibles detector has lost sensitivity and should be replaced. See Chapter 6, *Parts Replacement*, for instructions.
4. Recalibrate the combustibles detector using the procedures described in Chapter 4, *Calibration*. Be sure to calibrate the detector at the tagged flow rate. If the calibration tag is unreadable or has been lost, contact the factory for assistance.

If the steps in this section do not correct the *"Low Combustibles Reading"* error, contact the factory for assistance.

5.4 Calibration Responses

Chapter 4, *Calibration*, describes the procedures for calibrating the FGA 300H(X) in great detail. However, the response of the unit to the calibration procedures can provide valuable clues to potential problems with the installation. The three most common situations are described in this section.

5.4.1 Everything Is Fine

Calibration of the analyzer at the tagged calibration gas flow rate has been successfully completed. Upon switching off the calibration gas, the analyzer quickly returns to monitoring and displaying the flue gas concentrations accurately. This indicates that proper operating conditions have been achieved and the analyzer can be expected to perform reliably.

5.4.2 Forced Flow Problem

If a flow rate higher than the tagged calibration gas flow rate is required to calibrate the analyzer, either the flue gas velocity is too high or the probe is not perpendicular to the flue gas flow direction.

Under such conditions, the sample is not entering the probe by diffusion only, but it is being forced into the probe instead. In addition to the calibration problem, sensor/detector life may be shortened and analyzer plugging may occur. If forced flow is confirmed as the problem, refer to Chapter 2, *Installation*, for instructions on proper orientation of the analyzer.

5.4.3 Dead Space Problem

The analyzer was successfully calibrated at the tagged calibration gas flow rate, and the analyzer responded quickly to the calibration gas. However, there is a significant delay in reading the correct flue gas concentrations, after turning off the calibration gas.

When this problem occurs, it is very likely that the probe tip is located in a dead space. After the analyzer is correctly reading the flue gas concentration, switch on the calibration gas just long enough to get the correct reading. As soon as the analyzer reads the correct value, quickly shut off the calibration gas. One of two responses should occur:

1. If the recovery time is still too long, *plugging* may be the problem. Use of a blowback system (contact the factory for assistance) should clear the analyzer and restore proper operation.
2. If the analyzer reading recovers promptly, *dead space* is the likely problem. Furnace internal structures can cause dead spaces that are not evident from an external examination. Often, the installation of a longer probe may solve a dead space problem. However, it may sometimes be necessary to relocate the analyzer to a more suitable installation site.

If any situations not covered in this chapter are encountered, contact the factory for assistance.

[no content intended for this page]

Chapter 6. Parts Replacement

6.1 Overview

The FGA 300H(X) is designed to enable easy and quick servicing, if necessary. This chapter describes the replacement of major and minor components of the 300H(X). However, before actually replacing any component, carefully read the complete instructions to become familiar with the procedures.

Each section of this chapter gives a list of the equipment needed to complete the component replacement. Please make sure that any necessary replacement parts are on hand before dismantling the analyzer. In addition, the first paragraph of each section gives a description of the function and location of the part to be replaced.

IMPORTANT: *If the power must be disconnected to replace a part, perform the replacement as quickly as possible. The FGA 300H(X) is susceptible to corrosion from acid condensation, if it remains without power for more than about thirty minutes.*

If service procedures not covered in this chapter become necessary, please contact the factory for assistance.

WARNING! **To ensure safe operation of the FGA 300H(X), it must be installed and operated as described in this manual. In addition, be sure to follow all applicable local safety codes and regulations for installing electrical equipment.**

All procedures should be performed by trained service personnel.

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

6.2 Main Analyzer Unit

Those components associated with the basic sample system are located in the Sample System Compartment. This section describes the proper procedures for replacing these parts.

6.2.1 Removing the Cover

In order to access the sample system components, the cover must first be removed from the Sample System Compartment.

- Standard (weatherproof) FGA 300H:
  - **a.** Remove the blocking screw on one side of the cover (see Figure 13 on page 15).
  - **b.** Lift the cover up approximately 20mm (3/4”) and then pull it forward off the base.
- Explosion-proof (flameproof) FGA 300HX:
  - **a.** Loosen the locking set screw on the side of the Sample System Compartment (near the bottom) and unscrew the enclosure from the base of the unit.
  - **b.** Loosen the locking set screw on top of the Accessory Box and, using a long screwdriver across the slots provided, unscrew the cover from the enclosure.

WARNING! **There are extremely hot surfaces in the analyzer. If these surfaces are touched, serious burns could result. Use heat-resistant gloves when working within the Main Analyzer Unit.**

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

6.2.2 Replacing the Oxygen Sensor Clips

The oxygen sensor is connected to the electronics via two contact clips located at the base of the sensor. The *inner clip*, is inserted into the end of the oxygen sensor, while the outer clip simply snaps around the base of the sensor.

The following tools are needed to replace the oxygen sensor clips:

- pliers
- wire cutters
- wire strippers
- crimping tool

Power should remain on while replacing the oxygen sensor clips. Refer to Figure 35 while completing the following steps:

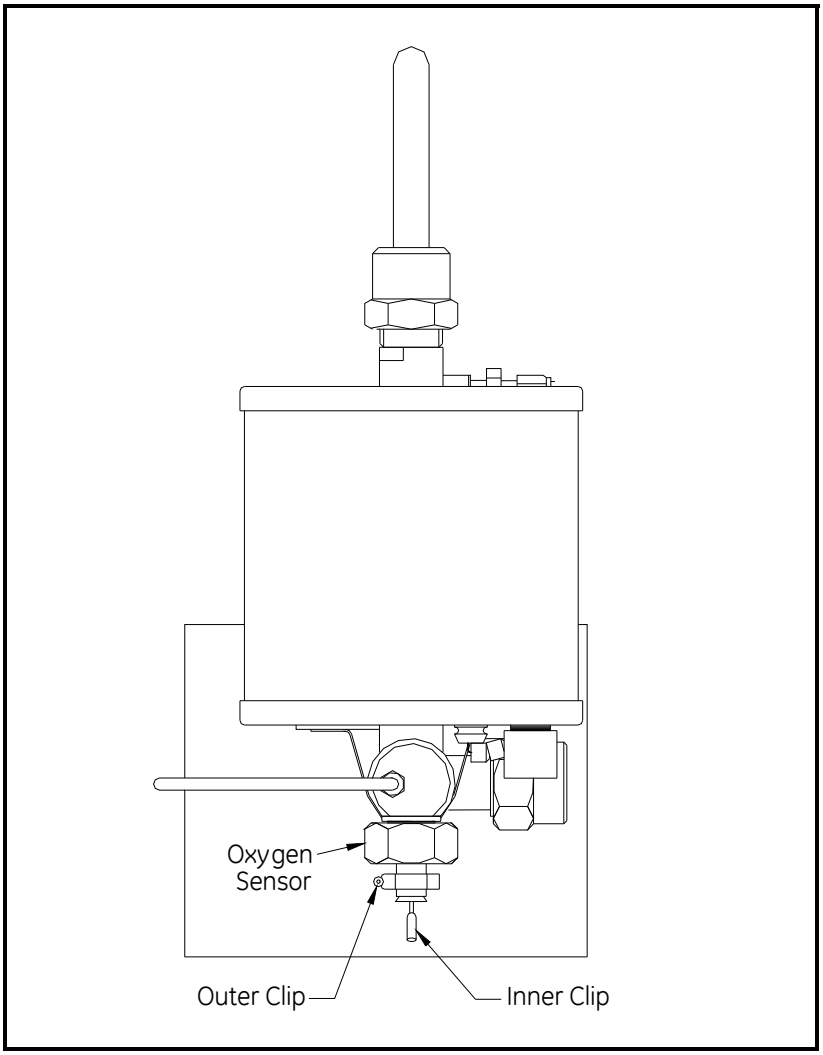

Figure 35: Oxygen Sensor Clips

6.2.2 Replacing the Oxygen Sensor Clips (cont.)

1. Remove the Sample System Compartment cover, as described in the *"Removing the Cover"* section on page 78.
2. Open the Accessory Box and disconnect the oxygen sensor leads from pins 1 and 2 of terminal block TB1.
3. Locate the oxygen sensor and the oxygen sensor clips (see Figure 35 on page 79).
4. Use pliers to remove the inner and outer clips from the oxygen sensor. To remove the inner clip, pinch the ends together and pull the clip out of the oxygen sensor. The outer clip is easily removed by pulling it away from the oxygen sensor body.
5. Making sure you do not cut off too much of the wire, cut off the old inner clip. The remaining wire should be left as long as possible.
6. Strip 13mm (1/2") of insulation off the inner clip wire.
7. Slide the new inner clip over the stripped wire.
8. Using a crimping tool, crimp the new inner clip onto the inner clip wire.
9. Repeat steps 4 through 7 to install the new outer clip. Reinstall both clips onto the oxygen sensor.
10. Reconnect the oxygen sensor leads to pins 1 and 2 of terminal block TB1 in the Accessory Box.
11. Install the Sample System Compartment cover by completing the steps in the *"Removing the Cover"* section on page 78 in reverse order, and close the Accessory Box cover.
12. Recalibrate the oxygen sensor as described in Chapter 4, *Calibration*.

This completes the replacement of the oxygen sensor clips.

6.2.3 Replacing the Oxygen Sensor

The oxygen sensor is mounted below the furnace and is readily accessible for quick and easy replacement. The following items are needed to replace the oxygen sensor:

- open-end wrench
- torque wrench
- Molykote® High-Temperature, Non-Silicone Lubricant
- pliers

Note: *When replacing the oxygen sensor, handle the sensor only by the fitting at its base.*

The oxygen sensor can be replaced with the sensor furnace either hot or cool. However, the procedures are slightly different, and particular attention should be paid to the noted variations in the following steps:

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

If replacing the oxygen sensor with a hot furnace, the power should remain on during the process and the following warning should be observed:

WARNING! There are extremely hot surfaces in the analyzer. Touching these surfaces will result in serious burns. Use heat-resistant gloves while replacing the oxygen sensor.

1. Remove the Sample System Compartment cover, as described in the *"Removing the Cover"* section on page 78.
2. Locate the oxygen sensor and the oxygen sensor clips (see Figure 35 on page 79). Use pliers to remove the inner and outer clips from the oxygen sensor. To remove the inner clip, pinch the ends together and pull the clip out of the oxygen sensor. The outer clip is easily removed by pulling it away from the oxygen sensor body.

6.2.3 Replacing the Oxygen Sensor (cont.)

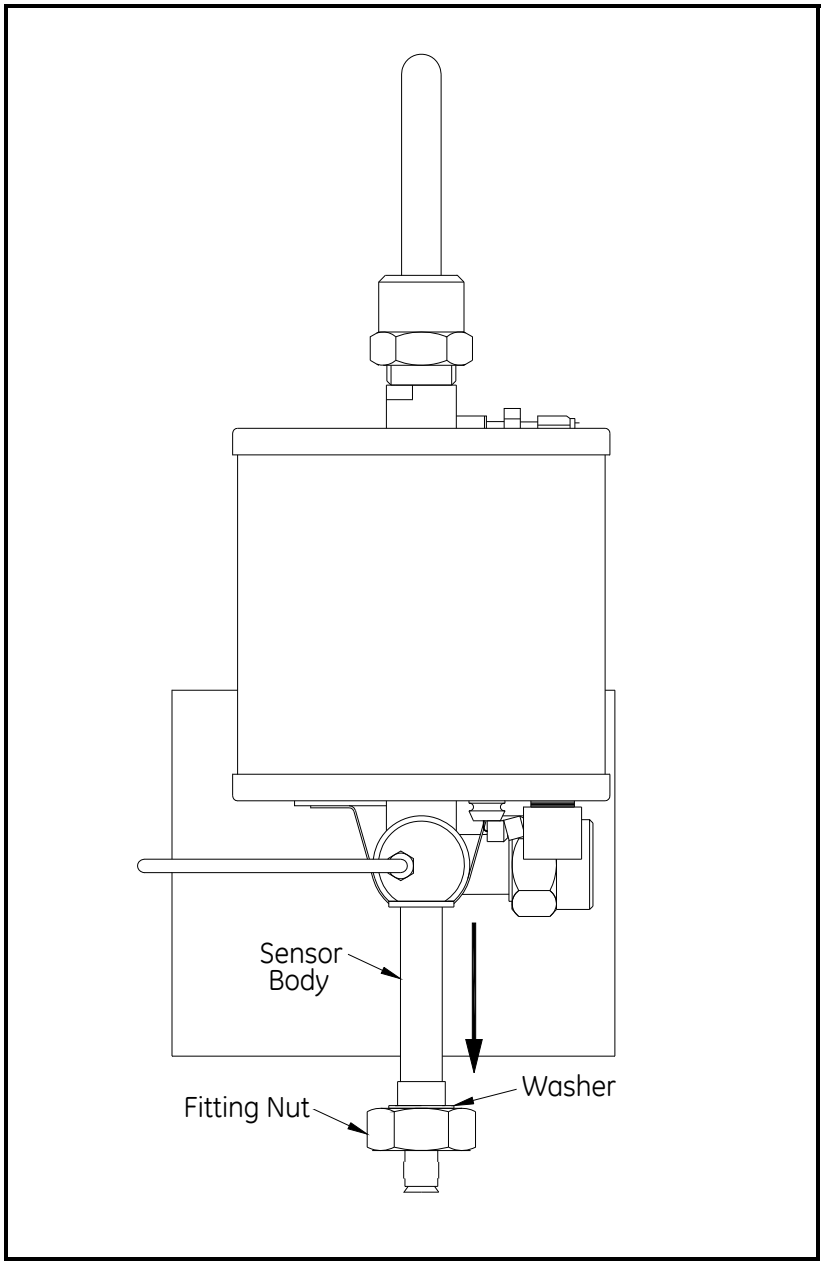

Figure 36: Partially Removed Oxygen Sensor

6.2.3 Replacing the Oxygen Sensor (cont.)

3. While wearing heat resistant gloves, slowly unscrew the fitting nut until it is completely free of its fitting. Carefully pull the oxygen sensor out of the sensor furnace making sure that the sensor does not hit the sides of the furnace during its removal. Figure 36 on page 82 shows an oxygen sensor that has been partially removed.

4. Lubricate the threads of the new oxygen sensor. GE recommends the use of Molykote® High-Temperature, Non-Silicon Lubricant for this purpose.

5. When replacing the oxygen sensor, handle it only by the fitting at its base. Carefully insert the new sensor into the bottom of the sensor furnace. Do not allow it to touch the sides of the sensor furnace.

IMPORTANT: *If the sensor furnace is hot, insert the new oxygen sensor slowly. Take 45-60 seconds to fully insert the sensor into the furnace. If the sensor is inserted too quickly, it will crack.*

6. After positioning the titanium washer against the fitting nut, finger tighten the oxygen sensor into its fitting on the bottom of the sensor furnace.

IMPORTANT: *If the sensor furnace is hot, allow the oxygen sensor to stand for at least two minutes before proceeding.*

7. Turn the fitting nut clockwise, as viewed from below the oxygen sensor, to securely tighten the oxygen sensor. Use a torque wrench set at 56 N-m (480 in.-lb) for this purpose.

IMPORTANT: *If the sensor furnace is hot, set the torque wrench at 70 N-m (600 in.-lb).*

8. Reinstall the inner and outer clips onto the oxygen sensor body.

9. Install the Sample System Compartment cover by completing the steps in the *"Removing the Cover"* section on page 78 in reverse order.

10. Calibrate the new oxygen sensor as described in Chapter 4, *Calibration.*

This completes the replacement of the oxygen sensor.

6.2.4 Replacing the Combustibles Detector

The combustibles detector is located on the side of the manifold, below the sensor furnace. The combustibles detector easily unscrews from the manifold and slips out of its housing.

CAUTION! The combustibles detector is very fragile. Handle it with great care.

An open-end wrench and a torque wrench are the only tools needed to replace the combustibles detector. To replace the combustibles detector, carefully complete the following steps:

WARNING! There are extremely hot surfaces in the Main Analyzer Unit. Touching these surfaces could result in serious burns. Use heat-resistant gloves while replacing the combustibles sensor.

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

1. Remove the Sample System Compartment cover, as described in the *"Removing the Cover"* section on page 78, and locate the combustibles detector on the side of the manifold.
2. Open the Accessory Box cover and disconnect the four combustibles detector leads from pins 7–10 of terminal block TB1 (there is also a jumper between pins 8 and 9).
3. Use a wrench to turn the retaining nut counterclockwise, as viewed from the end of the combustibles detector, until it comes loose from its fitting (see Figure 37 on page 85).
4. Slide the combustibles detector out of its housing.
5. Thread the wires of the new combustibles detector through the retaining nut, so that the threaded end of the nut is facing the combustibles detector body.
6. Remove the protective plastic cover from the new combustibles detector. Do not touch the two sensing elements on the end of the combustibles detector.

6.2.4 Replacing the Combustibles Detector (cont.)

7. Insert the new combustibles detector into its housing, being careful not to damage the two sensing elements, and tighten the retaining nut finger tight.

8. Orient the new combustibles detector with the active element above the reference element and the serial number label facing out, as shown in Figure 38 on page 86. Using a torque wrench set at 70 N-m (600 in.-lb), securely tighten the retaining nut by turning it clockwise, as viewed from the end of the combustibles detector.

9. Thread the four (4) combustibles detector leads to the location of terminal block TB1 in the Accessory Box.

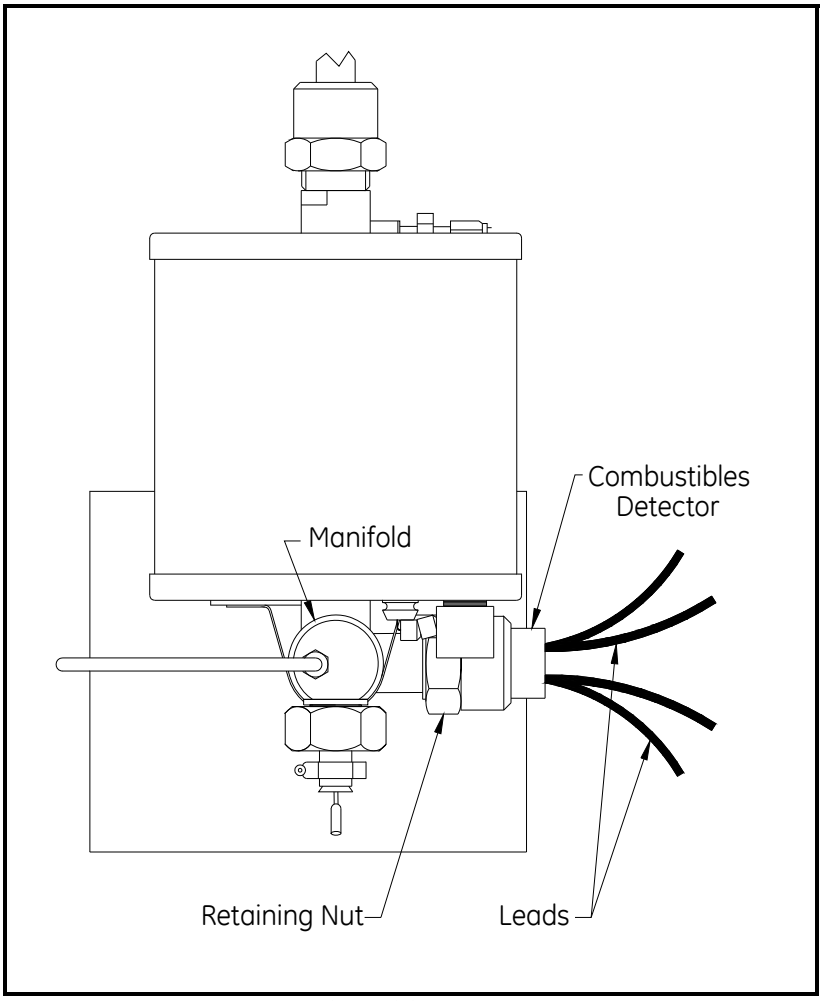

Figure 37: Combustibles Detector Location

6.2.4 Replacing the Combustibles Detector (cont.)

10. Connect the new combustibles detector leads to the appropriate pins on terminal block TB1 in the Main Accessory Box, as follows:

- active element leads to pins 7 and 8
- reference element leads to pins 9 and 10
- jumper between pins 8 and 9

Note: *The reference element leads are clearly marked with an "R" on bands located near the ends of the wires.*

11. Install the Sample System Compartment cover by completing the steps in the *"Removing the Cover"* section on page 78 in reverse order and close the Accessory Box cover.

12. Calibrate the new combustibles detector as described in Chapter 4, *Calibration*.

This completes the replacement of the combustibles detector.

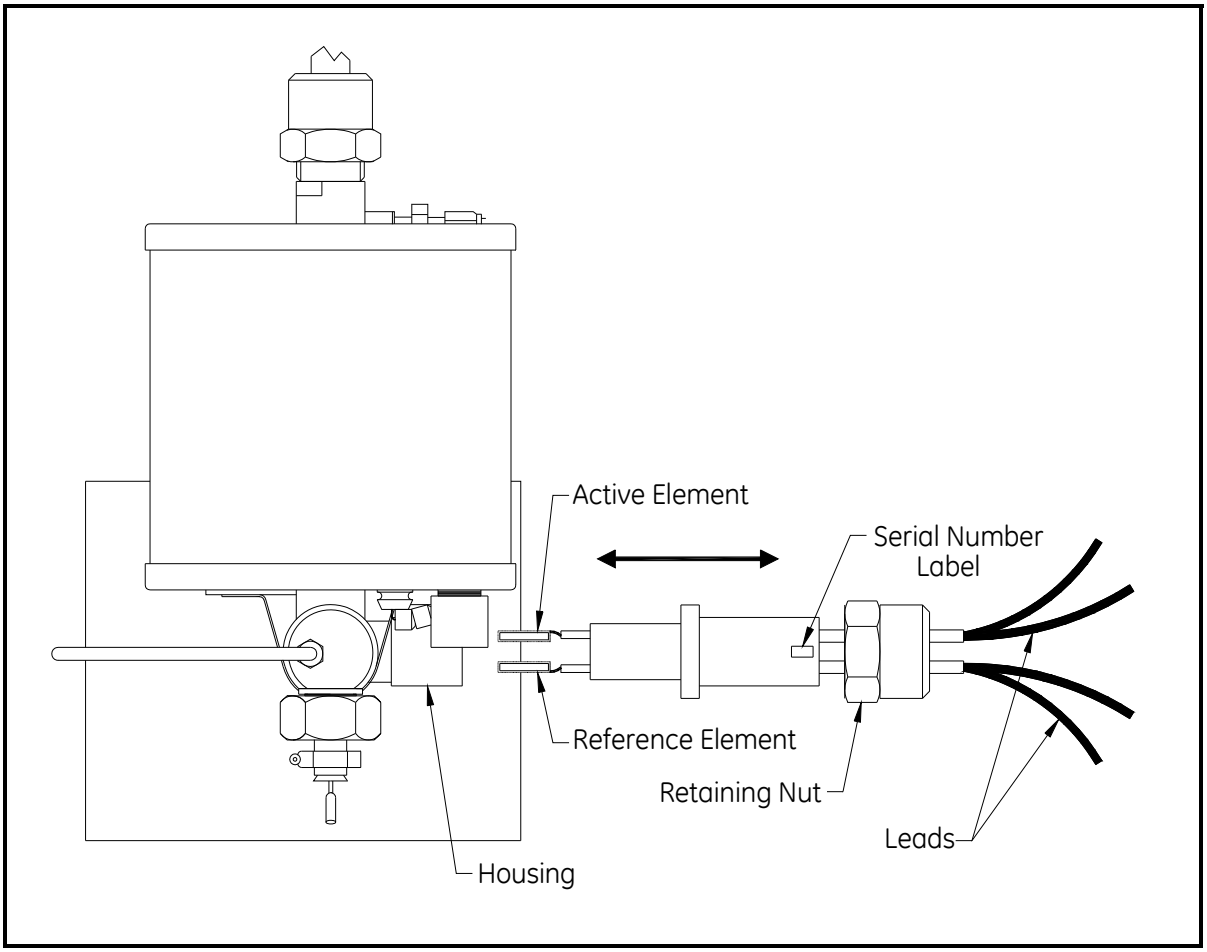

Figure 38: Combustibles Detector Orientation

6.2.5 Replacing the Temperature Sensor

The temperature sensor maintains the sensor furnace at a constant temperature. Either a resistance temperature detector (RTD) or a type K thermocouple (TC), as specified at the time of purchase, may be used for this purpose. The temperature sensor is mounted on the top of the sensor furnace and extends approximately 2" into the sensor furnace. The temperature sensor is fragile and easily damaged, and therefore, it must be handled with great care.

CAUTION! **To replace the temperature sensor, the power to the FGA 300H(X) must be disconnected. Therefore, replace the temperature sensor and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

A standard screwdriver is the only tool needed for replacement of the temperature sensor. Complete the following steps, in the order shown, to replace a defective temperature sensor:

1. Disconnect the main power to the FGA 300H(X).
2. Remove the Sample System Compartment cover, as described in the *"Removing the Cover"* section on page 78.
3. Open the Accessory Box cover and disconnect the temperature sensor leads from pins 3 and 4 on terminal block TB1.
4. Loosen the clamp that holds the temperature sensor to the bottom of the sensor furnace.
5. Extract the temperature sensor from the top of the sensor furnace. See Figure 39 on page 88, which shows a partially removed RTD type temperature sensor (the TC type temperature sensor is mounted and removed in a similar manner).

IMPORTANT: *Although the RTD and TC type temperature sensors are mounted and wired in the same manner, they are electrically different.* ***DO NOT*** *substitute one type in a unit configured for the other type.*

6. Insert the new temperature sensor into the sensor furnace, being careful not to strike it against the heating element or the pipe wall inside the sensor furnace.

6.2.5 Replacing the Temperature Sensor (cont.)

7. Tighten the clamp to secure the new temperature sensor to the top of the sensor furnace.

8. Thread the temperature sensor wires to the location of terminal block TB1 in the Accessory Box.

9. Connect the temperature sensor wire leads to pins 3 and 4 of terminal block TB1. Polarity is not important for an RTD type sensor, but the TC type must have the positive (yellow) lead connected to pin 3 and the negative (red) lead connected to pin 4.

10. Install the Sample System Compartment cover by completing the steps in the *"Removing the Cover"* section on page 78 in reverse order and close the Accessory Box cover.

11. Reconnect the main power to the unit and recalibrate the oxygen sensor as described in Chapter 4, *Calibration*.

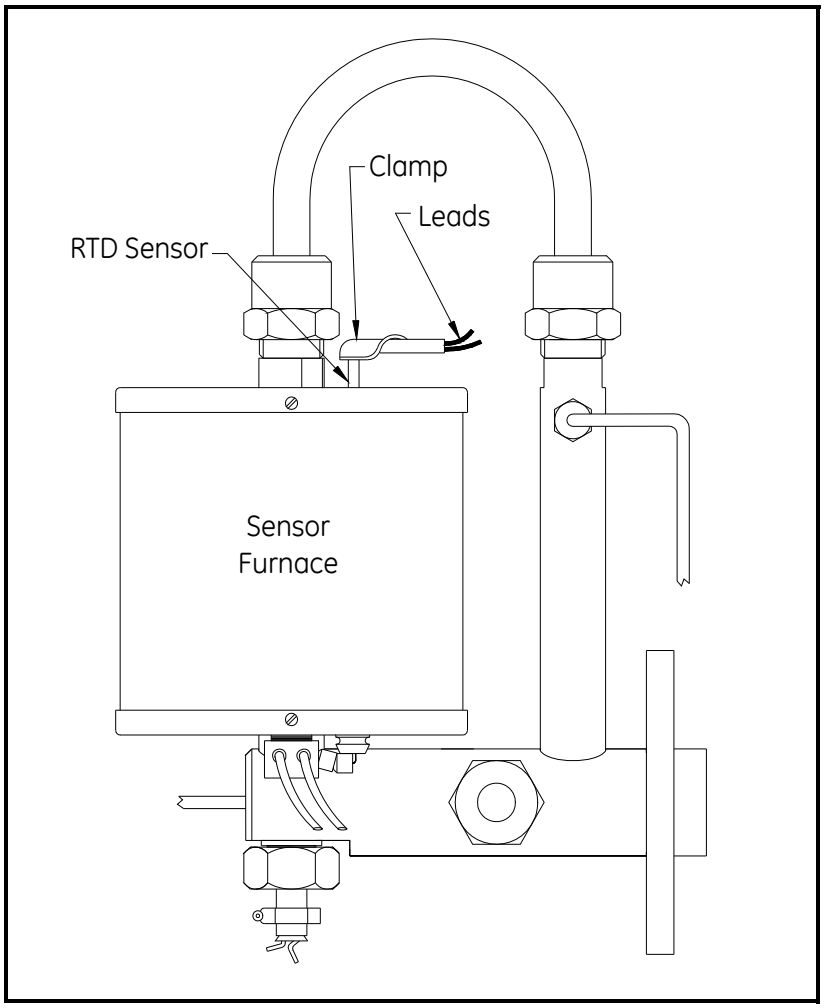

Figure 39: Temperature Sensor Location

6.2.6 Moving the Front Panel Assembly

The following three procedures, *Replacing the Sensor Furnace*, *Replacing the Cartridge Heaters* and *Replacing the Thermostat*, each require access to terminal block TB4, which is mounted on the back of the Front Panel Assembly. To make TB4 accessible, refer to Figure 40 and use the following procedure:

Note: *The* remote *version Accessory Box is shown in Figure 40. The TB4 location is the same for a* local *Accessory Box.*

1. Open the hinged cover on the Accessory Box.

2. Remove the four screws which support the front panel,

3. Rotate the Front Panel Assembly clockwise (slightly) to clear the flange, and carefully pull it straight out of the enclosure as far as the attached leads will allow.

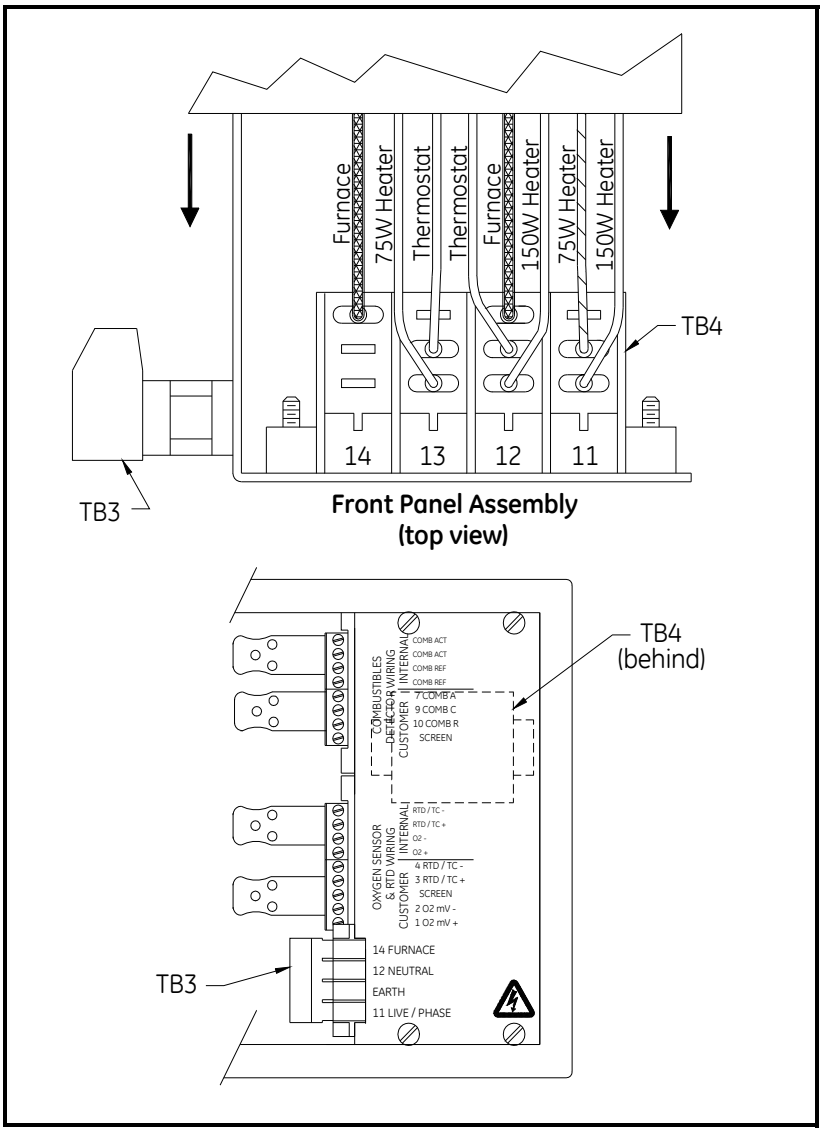

Figure 40: Main Accessory Box - TB4 Location

6.2.7 Replacing the Sensor Furnace

The sensor furnace maintains the oxygen sensor at a stable temperature, to ensure the accuracy of the percent oxygen readings and to extend the useful life of the oxygen sensor. The sensor furnace is located in the Sample System Compartment and is easily replaced. Replacement of the sensor furnace requires the following tools:

- open-end wrenches (2)
- torque wrench
- screwdriver
- digital multimeter

CAUTION! **To replace the sensor furnace, the power to the FGA 300H(X) must be disconnected. Therefore, replace the sensor furnace and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

6.2.7a Removing the Old Sensor Furnace

Complete the following steps in the order given to remove the old sensor furnace:

1. Disconnect the main power to the FGA 300H(X).
2. Remove the Sample System Compartment cover, as described in the *"Removing the Cover"* section on page 78.
3. Access terminal block TB4 by *Moving the Front Panel Assembly* on page 89.
4. Disconnect the sensor furnace power wires from TB4 pins 12 and 13 in the Accessory Box (see Figure 40 on page 89).
5. Remove the temperature sensor located on the top of the sensor furnace, as described in the *"Replacing the Temperature Sensor"* section on page 87. Place the temperature sensor aside, for later reinstallation.
6. Refer to Figure 41 on page 91 and place one open-end wrench on the flat surface machined into the piping just above the sensor furnace. Place a second open-end wrench on the nut directly above the first wrench.

6.2.7a Removing the Old Sensor Furnace (cont.)

7. The wrenches should be parallel to each other, but the top wrench should be positioned with its end rotated about 2 inches in a clockwise direction from the lower wrench. Refer to Figure 41 for a view of the wrenches from both the side and the bottom of the manifold assembly.

8. While holding the bottom wrench steady, turn the top wrench two inches toward the bottom wrench so that the two wrenches are aligned with each other.

Note: *Do not attempt to move the bottom wrench during the above step. Be sure to hold it in its original position.*

9. Repeat steps 6–8 to loosen the upper nut on the other end of the convection loop (see Figure 41).

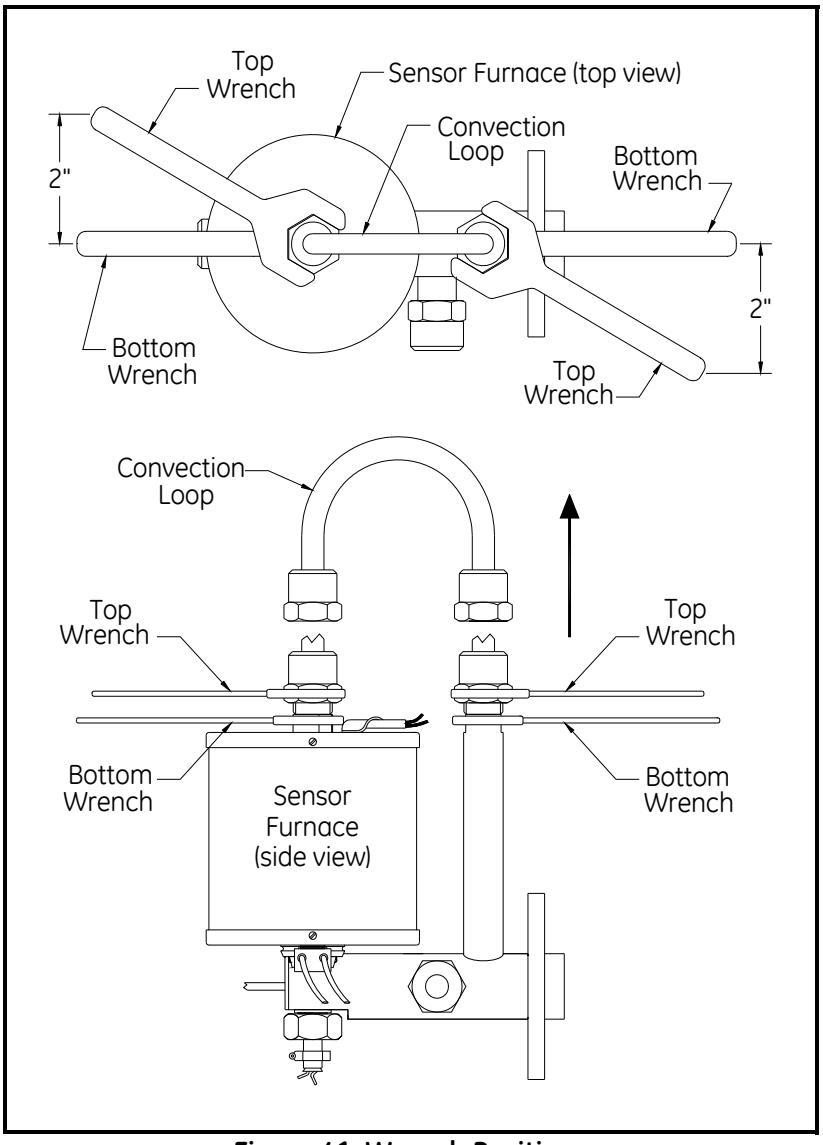

Figure 41: Wrench Positions

6.2.7a Removing the Old Sensor Furnace (cont.)

10. Unscrew both loosened nuts completely and lift the convection loop off the sensor furnace (see Figure 41 on page 91).

11. Use a screwdriver to remove the clamp on the bottom of the sensor furnace (see Figure 42).

WARNING! The sensor furnace may still be hot. Always use heat-resistant gloves when handling it.

12. Lift the sensor furnace straight up and off the assembly.

This completes the removal of the old sensor furnace. Install the new sensor furnace immediately, by completing the instructions in the next section.

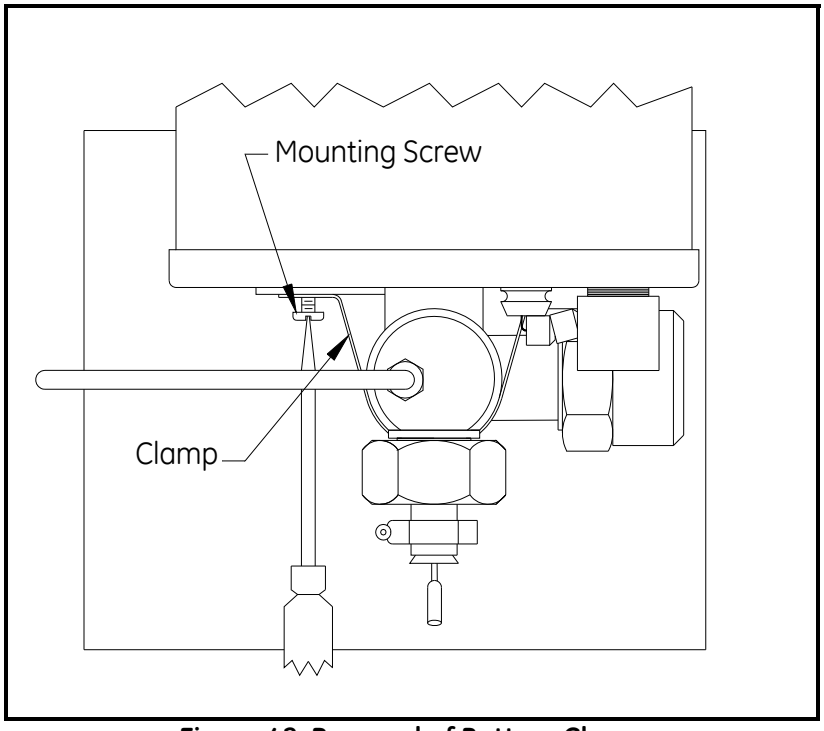

Figure 42: Removal of Bottom Clamp

6.2.7b Installing the New Sensor Furnace

The new sensor furnace is installed by completing the removal steps in reverse order. The specific procedure is as follows:

1. Locate the ceramic power block, which is on the bottom surface of the new sensor furnace.
2. Slide the new furnace into place. Make sure the ceramic block is on the bottom. Position the furnace so that the mounting hole in the bottom of the furnace lines up with the clamp.
3. Screw the clamp back onto the bottom of the furnace (see Figure 42 on page 92). Make sure the furnace does not vibrate or shake after you tighten the clamp.
4. Replace the temperature sensor (RTD) and secure it using the clamp. (For more information on inserting the RTD, consult the section, *Replacing the Temperature Sensor*, page 87.)

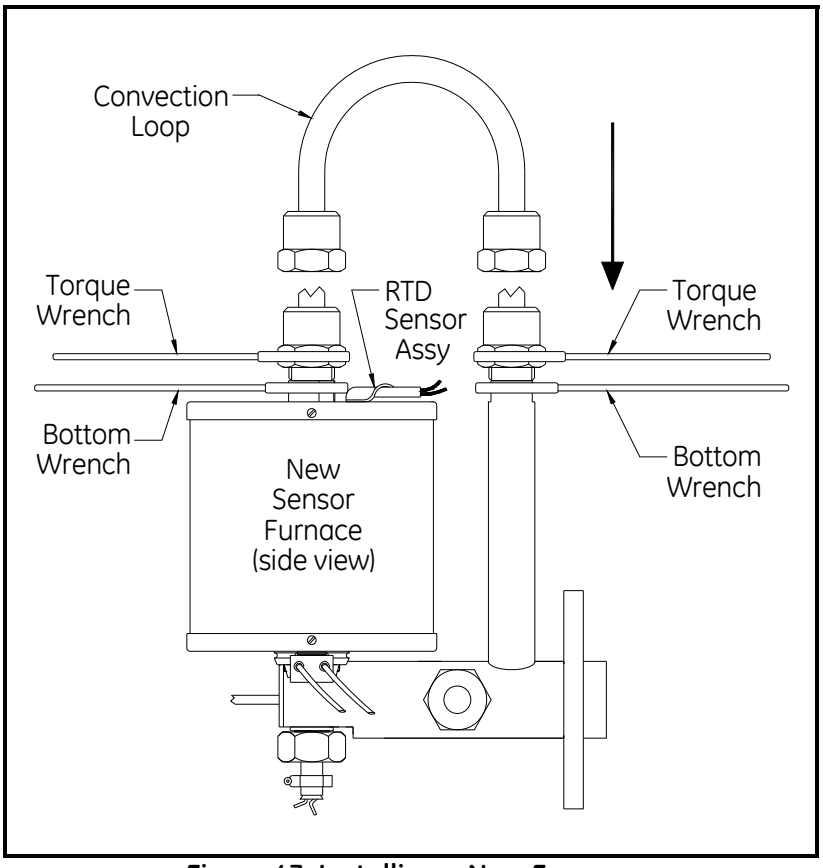

Figure 43: Installing a New Furnace

6.2.7b Installing the New Sensor Furnace (cont.)

5. Replace the convection loop by fitting it onto the piping.

6. Place a wrench on the flat surface of the piping at the top of the furnace. Using a torque wrench, set the torque to 70 N-m (600 in.-lb) and tighten the convection loop nut while holding the lower wrench steady.

7. To tighten the other nut on the convection loop, repeat step 6, using a torque setting of 63 N-m (540 in.-lb).

8. Reconnect the two previously removed wires to pins 12 and 14 on TB4 in the Accessory Box.

9. Using a digital multimeter, check the resistance of the sensor furnace heating element. Specific instructions may be found in Chapter 5, *Troubleshooting*.

6.2.7 Replacing the Sensor Furnace (cont.)

Assuming that the correct resistance reading was obtained in Step 9 above, replacement of the sensor furnace has been successfully completed. Conclude the procedure as follows:

1. Replace the Accessory Box front panel by completing the steps in the *Moving the Front Panel Assembly* section on page 89 in reverse order.

2. Install the Sample System Compartment cover by completing the steps in the *"Removing the Cover"* section on page 78 in reverse order.

3. Reconnect the main power to the unit and recalibrate the oxygen sensor as described in Chapter 4, *Calibration*.

6.2.8 Replacing the Cartridge Heaters

A heater block is mounted on the end of the 300H(X) Main Analyzer Unit. The cartridge heaters (≈3-1/2" long cylinders) and a thermostat are located inside this heater block (see Figure 44).

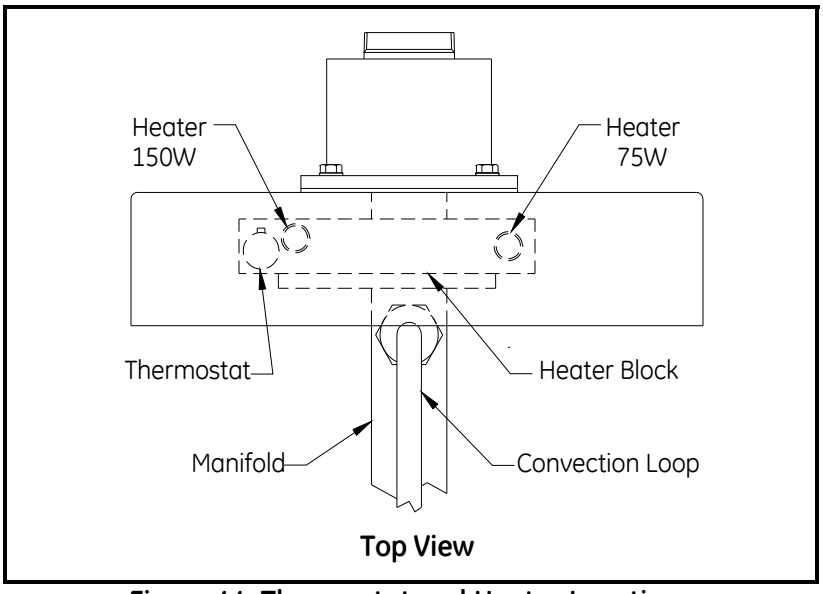

Figure 44: Thermostat and Heater Locations

The following items are required to replace the cartridge heaters:

- wire cutters
- wire strippers
- Watlube® Heat Transfer and Release Agent

CAUTION! **To replace the cartridge heaters, the power to the FGA 300H(X) must be disconnected. Therefore, replace the cartridge heaters and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

WARNING! **There are extremely hot surfaces in the Main Analyzer Unit. If they are touched, serious burns could result. Always use heat-resistant gloves when replacing the cartridge heaters.**

To replace the cartridge heaters, complete the following steps:

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

6.2.8a Removing the Old Cartridge Heater

1. Disconnect the main power to the FGA 300H(X).

2. Remove the Sample System Compartment cover, as described in the *"Removing the Cover"* section on page 78.

3. Access terminal block TB4 by *Moving the Front Panel Assembly* on page 89.

4. Locate the cartridge heaters in the heater block near the bottom of the Sample System Compartment (see Figure 44 on page 95). The cartridge heater wires come out the bottom of the heater block.

5. Trace the two wires from the cartridge heater being replaced (75W or 150W) to pins 11 and 13, or 12 and 13 on terminal block TB4 in the Accessory Box (see Figure 40 on page 89).

6. Disconnect the two wires which correspond to the heater being replaced (75W or 150W). Be sure to disconnect **ONLY** the cartridge heater wires at pins 11 and 13 or 12 and 13 on terminal block TB4.

IMPORTANT: *Do not disconnect any of the other leads at these terminals.*

7. Push on the cartridge heater to be replaced from the bottom end (with wires), while pulling the same cartridge heater out the top side of the heater block.

8. Feed the cartridge heater wires up through the hole from the Accessory Box into the Sample System Compartment and through the heater block.

6.2.8b Installing the New Cartridge Heater

1. Brush a thin coat of a heat transfer agent on the new cartridge heater. GE recommends Watlube® Heat Transfer and Release Agent.
2. Pass the wires on the new cartridge heater down through the heater block, slide the new cartridge heater into place, and feed the wires to terminal block TB4 in the Accessory Box.
3. Strip the ends of both cartridge heater wires.
4. Crimp connectors onto the wires.
5. Connect each of the wires to the appropriate terminals on TB4 (see Figure 40 on page 89)
   - 75W heater wires to terminals 11 and 13,
   - 150W heater wires to terminals 11 and 12.
6. Replace the Accessory Box front panel by completing the steps in the *Moving the Front Panel Assembly* section on page 89 in reverse order.
7. Install the Sample System Compartment cover by completing the steps in the *"Removing the Cover"* section on page 78 in reverse order, and reconnect the main power to the unit.

This completes the replacement of the cartridge heaters.

6.2.9 Replacing the Thermostat

The thermostat, which is approximately the same length as the heater block, is located in the heater block at the end of the Main Analyzer Unit. The thermostat regulates the temperature of the heater block to approximately 225°C. If the thermostat is defective or it is removed, the heater block will quickly cool down.

The following items are needed to replace the thermostat:

- wire cutters
- wire strippers
- Watlube® Heat Transfer and Release Agent

CAUTION! **To replace the thermostat, the power to the FGA 300H(X) must be disconnected. Therefore, replace the thermostat and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

WARNING! **There are extremely hot surfaces in the Main Analyzer Unit. If they are touched, serious burns could result. Always use heat-resistant gloves when replacing the thermostat.**

IMPORTANT: *These symbols indicate Caution - dangerously hot surfaces and risk of electric shock, respectively:*

Removing the Old Thermostat

Use the following procedures and refer to Figure 44 on page 95 to complete the thermostat replacement:

1. Disconnect the main power to the FGA 300H(X).
2. Remove the Sample System Compartment cover, as described in the *"Removing the Cover"* section on page 78.
3. Access terminal block TB4 by *Moving the Front Panel Assembly* on page 89.
4. The thermostat is located next to one of the cartridge heaters, in the heater block near the bottom of the Sample System Compartment. The thermostat wires come out the top of the heater block.
5. Trace the thermostat wires from the end of the thermostat to pins 12 and 13 on terminal block TB4 in the Accessory Box.
6. Disconnect the two wires which correspond to the thermostat. Be sure to disconnect **ONLY** the thermostat wires at pins 12 and 13 on terminal block TB4.

IMPORTANT: *Do not disconnect any other leads at these terminals.*

7. Remove the old thermostat by pulling it out of the heater block.

6.2.9a Installing the New Thermostat

1. Brush a thin coat of a heat transfer agent, such as Watlube® Heat Transfer and Release Agent, on the new thermostat.
2. Slide the new thermostat into the heater block and feed the wires down to TB4 in the Accessory Box.
3. Strip the ends of the two new thermostat wires.
4. Crimp connectors onto the wires.
5. Connect the wires to TB4 terminals 12 and 13 (see Figure 40 on page 89). Polarity is not important.
6. Replace the Sample System Compartment front panel by completing the steps in the *Moving the Front Panel Assembly* section on page 89 in reverse order.
7. Install the Sample System Compartment cover by completing the steps in the *"Removing the Cover"* section on page 78 in reverse order, and reconnect the main power to the unit.

This completes the replacement of the thermostat.

6.3 FTC Board

The major component associated with the operation of the sensor furnace is the Furnace Temperature Control (FTC) board, which may be located in either the Main Analyzer Unit Accessory Box or a Remote FTC Box.

Note: *Some older units also have a* transformer *to supply the 80 VAC required by previous FTC board designs. See Appendix F,* Previous Configurations*, for additional information on these units.*

6.3.1 Replacing a Local FTC Fuse

The Furnace Temperature Control (FTC) fuse for local wiring is located on the front panel assembly, inside the Accessory Box.

CAUTION! **To replace the FTC fuse, the power to the FGA 300H(X) must be disconnected. Therefore, replace the FTC fuse and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

The only tool needed to replace the FTC fuse is a screwdriver. Refer to Figure 45 on page 100 and complete the following steps to replace the FTC fuse:

1. Disconnect the main power to the unit.
2. Open the hinged cover on the standard Accessory Box.
3. Locate the fuseholder on the front panel. Using a screwdriver, remove the spring-loaded cover from the fuseholder and discard the old fuse.
4. Install a new fuse of the same type and size (see the label near the fuseholder or Chapter 7, *Specifications*), and reinstall the fuseholder cover.
5. Close the cover on the Accessory Box and reconnect the main power to the system.

The system may now be placed back into service.

6.3.1 Replacing a Local FTC Fuse (cont.)

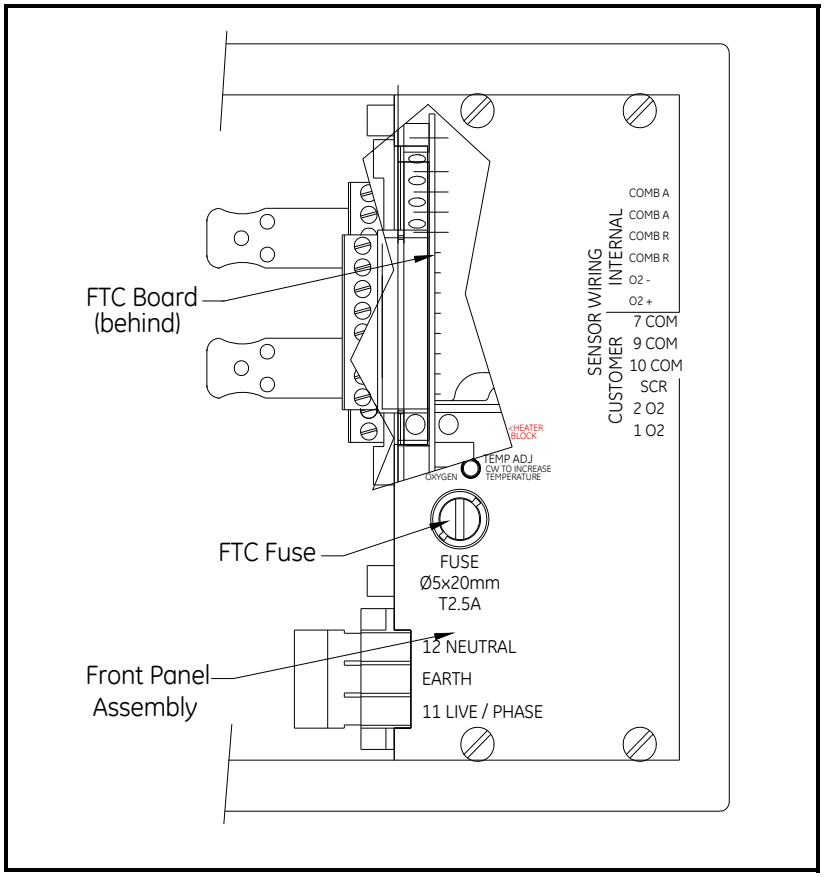

Figure 45: Local FTC Fuse and FTC Board Locations

6.3.2 Replacing a Local FTC Board

The Furnace Temperature Control (FTC) board for local wiring is located behind the front panel in the Accessory Box (see Figure 45). The FTC board is a 3.5 x 4.7 in. (90 x 120 mm) rectangular printed circuit board that maintains a steady sensor furnace temperature in order to ensure accurate operation of the oxygen sensor.

CAUTION! **To replace the FTC board, the power to the FGA 300H(X) must be disconnected. Therefore, replace the FTC board and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

The only tool needed to replace the FTC board is a screwdriver. Refer to Figure 45 on page 100 and complete the following steps to replace the FTC board:

1. Open the hinged cover on the standard Accessory Box.
2. Disconnect the main power to the unit by removing three wires from TB3; pins 11, 12 and Earth.
3. Remove the four screws which support the front panel.
4. Rotate the Front Panel Assembly clockwise (slightly) to clear the flange, and carefully pull it straight out of the enclosure as far as the attached leads will allow.
5. Remove the connectors from the 5-pin terminal block (TB1) and the 8-pin terminal block (TB2) on the FTC board.
6. Remove the four screws and washers located in the corners of the old FTC board, and lift the FTC board out of the enclosure.

Note: *Install the new board in the same orientation as the old board. The line voltage and temperature sensor type for the new FTC board are factory set, based on the unit's serial number.*

7. Locate the new FTC board over the standoffs in the enclosure, replace the four screws and washers in the corners, and tighten the screws securely.
8. Reinsert the 5-pin and 8-pin connectors into their corresponding terminal blocks.
9. Reinstall the front panel assembly with its four mounting screws.
10. Close the cover on the Accessory Box and reconnect the main power to the system.
11. Refer to Chapter 4, *Calibration*, and recalibrate the oxygen sensor and the combustibles detector.

This completes the replacement of the local FTC board.

6.3.3 Replacing a Remote FTC Board Fuse

The Furnace Temperature Control (FTC) fuse for remote wiring is located on the FTC board.

CAUTION! **To replace the FTC board fuse, the power to the FGA 300H(X) must be disconnected. Therefore, replace the FTC board fuse and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

The only tool needed to replace the remote FTC board fuse is a small screwdriver. Refer to Figure 46 on page 104 and complete the following steps to replace the FTC board fuse:

1. Disconnect the main power to the FGA 300H(X).
2. Open the hinged cover on the standard (weatherproof) FTC box. For an explosion-proof (flameproof) FTC box, loosen the locking set screw on top of the FTC box and, using a long screwdriver across the slots provided, unscrew the cover from the enclosure.
3. Locate the fuseholder on the FTC board. Using a small screwdriver, remove the spring-loaded cover from the fuseholder and discard the old fuse.
4. Install a new fuse of the same type and size (see the label near the fuseholder or Chapter 7, *Specifications*), and reinstall the fuseholder cover.
5. Close the cover on the remote FTC Box and reconnect the main power to the system.

The system may now be placed back into service.

6.3.4 Replacing a Remote FTC Board

The Furnace Temperature Control (FTC) board for remote wiring is located in a Remote FTC box. The FTC board is a 3.5 x 4.7 in. (90 x 120 mm) rectangular printed circuit board that maintains a steady sensor furnace temperature in order to ensure accurate operation of the oxygen sensor.

CAUTION! **To replace the FTC board, the power to the 300H(X) FGA must be disconnected. Therefore, replace the FTC board and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

The only tool needed to replace the remote FTC board is a screwdriver or similar tool. Refer to Figure 46 on page 104 and complete the following steps to replace the FTC board:

1. Disconnect the main power to the FGA 300H(X).
2. Open the hinged cover on the standard (weatherproof) FTC box. For an explosion-proof (flameproof) FTC box, loosen the locking set screw on top of the FTC box and, using a long screwdriver across the slots provided, unscrew the cover from the enclosure.
3. Remove the connectors from the 5-pin terminal block (TB1) and the 8-pin terminal block (TB2) on the FTC board.
4. Remove the four screws located in the corners of the old FTC board, and lift the FTC board out of the enclosure.

Note: *Install the new board in the same orientation as the old board. The line voltage and temperature sensor type for the new FTC board are factory set, based on the unit's serial number.*

5. Locate the new FTC board over the standoffs in the enclosure. Make sure that the new FTC board is in the same orientation as the old board and not rotated by 180°.
6. Replace the four screws in the corners of the new FTC board, and tighten them securely.

6.3.4 Replacing a Remote FTC Board (cont.)

7. Reconnect the connectors to the 5-pin terminal block (TB1) and the 8-pin terminal block (TB2) on the new FTC board.

8. Close the cover on the remote FTC Box and reconnect the main power to the system.

9. Refer to Chapter 4, *Calibration*, and recalibrate the oxygen sensor and the combustibles detector.

This completes the replacement of the remote FTC board.

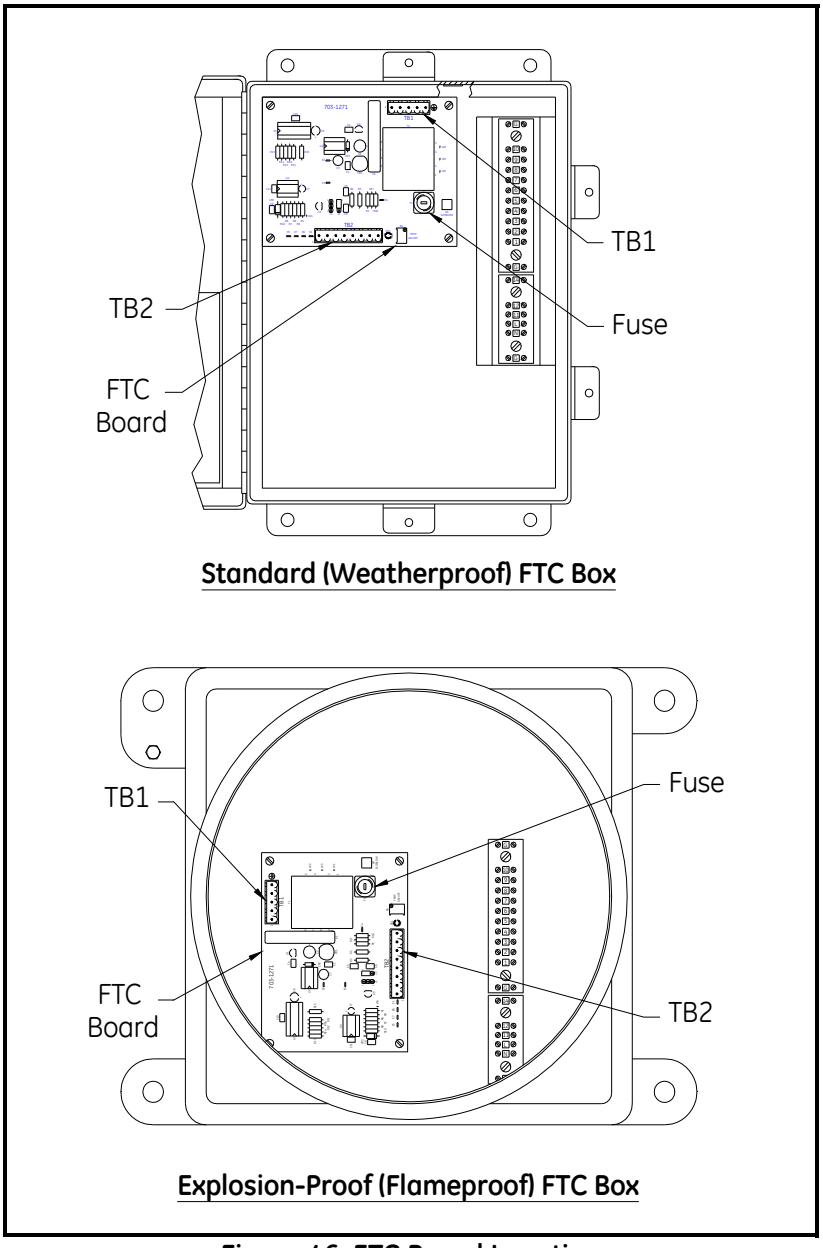

Figure 46: FTC Board Location

6.4 Display Electronics Console

There are no user-serviceable components in the Display Console, except for the fuse on the display board. Refer to Chapter 7, *Specifications*, for the size and type of the display board fuse.

6.4.1 Replacing the Display Board Fuse

The display board fuse is located on the digital display printed circuit board in the 300D Display Console.

CAUTION! **To replace the display board fuse, the power to the FGA 300H(X) must be disconnected. Therefore, replace the display board fuse and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

The only tool needed to replace the display board fuse is a screwdriver. Refer to Figure 47 and complete the following steps to replace the display board fuse:

1. Disconnect the main power to the FGA 300H(X).
2. Open the hinged cover on the standard Display Console. For the panel mount, bench mount or rack mount versions, the fuseholder is accessible through the back panel.
3. Locate the fuseholder on the display board. Using a screwdriver, remove the spring-loaded cover from the fuseholder and discard the old fuse.
4. Install a new fuse of the same type and size (see the label near the fuseholder or Chapter 7, *Specifications*), and reinstall the fuseholder cover.

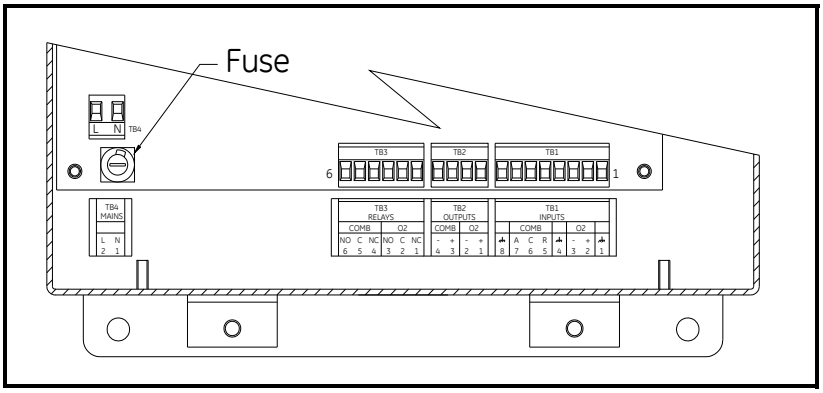

Figure 47: Display Board Fuse

5. Close/replace the cover on the Display Console and reconnect the main power to the system.

There are no other user-serviceable components in the Display Console. If it is suspected that this unit is defective, please contact the factory for assistance.

6.5 Spare Parts

In order to perform the service procedures described in this chapter, the required spare parts must be purchased from GE.

WARNING! The use of unauthorized spare parts will void the warranty. Non-factory parts may cause damage to the instrument and/or may present a serious safety hazard to the operator.

For convenience, the most commonly needed spare parts for the 300D Digital Display are listed below in Table 20, and for the FGA 300H(X) in Table 21 on page 107. To purchase any parts, whether listed or not, contact the factory for assistance.

Table 20: Spare Parts List - 300D Digital Display

Part Number	Qty	Description
1703-001-02	1	Linear Board, Oxygen Channel, 115VAC
1703-001-03	1	Linear Board, Oxygen Channel, 220VAC
1703-001-04	1	Linear Board, Combustibles Channel, 115VAC
1703-001-05	1	Linear Board, Combustibles Channel, 220VAC
1703-001-06	1	Linear Board, Oxygen and Combustibles Channel, 115VAC
1703-001-07	1	Linear Board, Oxygen and Combustibles Channel, 220VAC
1703-002-02	1	Display Board, Oxygen Channel
1703-002-03	1	Display Board, Combustibles Channel
1703-002-04	1	Display Board, Oxygen and Combustibles Channel
1193-504	5	Fuse - 200mA
1193-503	5	Fuse - 100mA (for 220VAC units)

6.5 Spare Parts (cont.)

Table 21: Spare Parts List - FGA 300H(X)

Part Number	Qty	Description
1214-511	1	Inner Oxygen Sensor Clip
1214-510	2	Outer Oxygen Sensor Clip
1705-533	2	Combustibles Detector Assembly
1705-534	1	RTD Assembly
1190-505-01	1	Thermostat and Leads
1227-502-01	2	Cartridge Heater 150W, 115VAC
1227-502-02	2	Cartridge Heater 150W, 220VAC
1227-505-01	2	Cartridge Heater, 75W, 115VAC
1227-505-02	2	Cartridge Heater, 75W, 220VAC
1420-520-01	1	Heater Block, 300H, 300V
1420-520-02	1	Heater Block, 300HX, 300V
1410-502	1	Gasket, Hi Temp
1705-546	1	Thermocouple (K-Type) Temperature Detector Assembly
1193-501	5	Fuse, 2.5A
1705-526-01	1	Oxygen Sensor Assembly - Std. Gases
1705-526-02	1	Oxygen Sensor Assembly - Stoichiometric Combustion (CO)
1703-1271-02	1	Temperature Control Board - 115VAC (K Type Thermocouple input)
1703-1271-03	1	Temperature Control Board - 220VAC (K Type Thermocouple input)
1703-1271-04	1	Temperature Control Board - 115VAC (RTD input)
1703-1271-05	1	Temperature Control Board - 220VAC (RTD input)
1705-552-02	1	Furnace Assembly with bracket
1705-549-01	1	Cal Port Flowmeter, 300H
1705-549-02	1	Cal Port Flowmeter, 300HX
1781-505	1	Plug, 8mm, Serto
1420-619	1	Flow Shield
1781-525	1	Internal Calibration Tube, 300H
1781-511	1	Calibration Stub, 6mm
1781-504	1	Bulkhead Fitting - Cal Port

[no content intended for this page]

Chapter 7. Specifications

7.1 General Specifications

Response Time:

20 seconds to within 90% of a step change

Sample Probe Length:

Standard: 0.6 m (24 in.) high temperature resistant steel

Optional: 1.0 m (39 in.), 1.4 m (55 in.), or special lengths

Sample Dew Point:

180°C (356°F) maximum (higher dew point version available)

Ambient Temperature:

Analyzer: -25° to 70°C (-13° to 158°F) (higher temperature version available)

Digital Display Unit: -10° to 50°C (14° to 122°F)

Power Requirement:

Maximum on Start-up (±10%):

400W max. @115/230 VAC, 50/60 Hz (dropping to ~250W when at temperature)

Fuses:

Anti-Surge, T-Type, 5x20 mm

FTC Board: 2.5 A

Digital Display Board: 200 mA @115 VAC, 100 mA @230 VAC

Warm-Up Time:

Meets specified accuracy within one hour

Area Classification for FGA 300H:

II 2 G EEx d IIC T4, ISSeP 04ATEX078X

Note: *As a special consideration for certification, the flue gas can not generate an explosive atmosphere. After removing power, wait 5 minutes before opening.*

European Compliance:

The unit complies with EMC Directive 2004/108/EC and the 2006/95/EC Low Voltage Directive (Installation Category II, Pollution Degree 2). For EN 61000-4-3, the FGA 300H(X) meets Performance Criterion A, except at a limited number of frequencies, Criterion B, per EN 61326.

7.2 Oxygen Specifications

Sensor:

Stabilized zirconium oxide (zirconia) ceramic

Accuracy:

Logarithmic Output: ±1% of reading

Linear Output: ±1% of full scale

Repeatability:

Logarithmic Output: ±0.2% of reading

Linear Output: ±0.5% of full scale

Drift:

Less than 0.1% of sensor output per month

Sample Temperature:

950°C (1,742°F) maximum (higher sample temperature version available)

Calibration:

Through calibration port using a certified mixture of O_2 in N_2

7.3 Combustibles Specifications

Detector:

Catalytic combustion platinum resistance thermometer

Accuracy:

±5% of reading

Repeatability:

±1% of full scale

Drift:

Less than 2% of full scale per month

Sample Dew Point:

180°C (356°F) maximum (higher dew point version available)

Calibration:

Through calibration port using a certified mixture of CO and H_2 in N_2 with O_2

7.4 Available Options

Some of the available options for the 300H(X) Flue Gas Analyzer are listed below:

- Remote logarithmic meter
- Dual alarm contacts for oxygen or combustibles
- Flameproof analyzer:
  CENELEC EEx d IIB T3 ISSEP cert. #01E.103.1315 X

Note: *As a special consideration for certification, the flue gas can not generate an explosive atmosphere.*

- Sample probe lengths up to 1.4 m
- Analyzers for sampling at flue gas temperatures up to 1,700°C (3,092°F) and/or flue gas acid dew points higher than 180°C (356°F)
- Analyzers for ambient temperatures higher than 70°C (158°F)

Consult the factory for additional information.

7.5 Ordering Information

The information below shows how the FGA 300H Part Number is configured from the options specified.

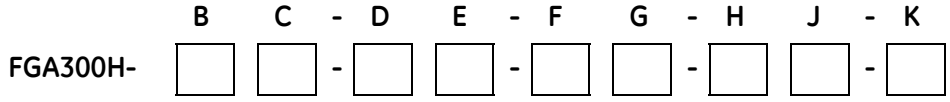

Table 22: FGA 300H Weatherproof Ordering Information

LTR	CATEGORY	OPTIONS
B	Oxygen Sensor	0 = None 1 = Standard oxygen sensor (type 1) **2** = Oxygen sensor for stoichiometric combustion (type 2)
C	Combustibles Detector	**0** = None **1** = Standard combustibles detector with flowmeter
D	Power	**1** = 100 VAC **2** = 110 / 120 VAC **3** = 220 VAC **4** = 240 VAC
E	Furnace Controller Enclosure	**0** = No furnace temperature control card (Spares orders only) **1** = Local furnace temperature control **3** = Remote Weatherproof FTC enclosure (IP65) **5** = 304 SS remote Weatherproof FTC enclosure (IP65) **S** = Special
F	Mounting	**1** = 1-1/2” male NPT thread mounting **2** = DN80 PN16 flange C.S. mounting **3** = ANSI 3” 300 lb flange C.S. mounting **4** = Two flanges with gasket - DN80 PN16 C.S. for mounting **5** = Two flanges with gasket - ANSI 3” 300 lb C.S. for mounting **6** = ANSI 4” 150 lb flange C.S. mounting **7** = Two flanges with gasket - ANSI 4” 150 lb C.S. for mounting **S** = Special
G	Aspirator	**0** = Diffusion / convection based sampling **1** = Aspirator included **S** = Special
H	External Port Connections	**0** = 6mm external port connections **1** = 1/4” external port connections
J	Special	**0** = None **1** = Flowmeter and valve for calibration port **2** = Tropicalized electronics **S** = Special
K	Temperature Control Setting	**0** = Standard temperature setting: 700°C **S** = Special temperature setting: (770°/812°C - please specify)
Note: *Option J=1 is not required for units with combustibles detectors, as the flowmeter is supplied with option B=1. Option J=1 is available for “Oxygen only” units.*		
Note: *Oxygen sensor types: Type 1 is a plasma-sprayed cell and is the standard cell. Type 2 is a coated plasma-sprayed cell intended for applications where percent levels of CO are expected.*		

7.5 Ordering Information (cont.)

The information below shows how the FGA 300HX Part Number is configured from the options specified.

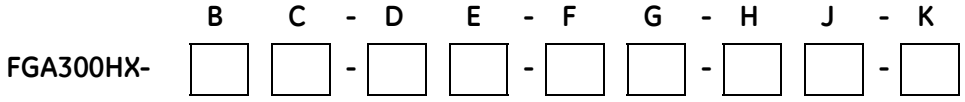

Table 23: FGA 300HX Explosion-Proof Ordering Information

LTR	CATEGORY	OPTIONS
B	**Oxygen Sensor**	0 = None 1 = Standard oxygen sensor (type 1) **2** = Oxygen sensor for stoichiometric combustion (type 2)
C	**Combustibles Detector**	**0** = None **1** = Standard combustibles detector with flowmeter
D	**Power**	**1** = 100 VAC **2** = 110 / 120 VAC **3** = 220 VAC **4** = 240 VAC
E	**Furnace Controller Enclosure**	**0** = None **3** = Remote Weatherproof FTC enclosure (IP65) **4** = Remote Flameproof FTC enclosure (II 2 G EEx d IIC) **5** = 304 SS remote Weatherproof FTC enclosure (IP65) **6** = Display unit **S** = Special
F	**Mounting**	**2** = DN80 PN16 flange C.S. mounting **3** = ANSI 3” 300 lb flange C.S. mounting **4** = Two flanges with gasket - DN80 PN16 C.S. for mounting **5** = Two flanges with gasket - ANSI 3” 300 lb C.S. for mounting **6** = ANSI 4” 150 lb flange C.S. mounting **7** = Two flanges with gasket - ANSI 4” 150 lb C.S. for mounting **S** = Special
G	**Aspirator**	**0** = Diffusion / convection based sampling **1** = Aspirator included **S** = Special
H	**External Port Connections**	**0** = 6mm external port connections **1** = 1/4” external port connections
J	**Special**	**0** = None **1** = Flowmeter and valve for calibration port **2** = Tropicalized electronics **S** = Special
K	**Temperature Control Setting**	**0** = Standard temperature setting: 700°C **S** = Special temperature setting: (770°/812°C - please specify)
Note: *Option J=1 is not required for units with combustibles detectors, as the flowmeter is supplied with option B=1. Option J=1 is available for “Oxygen only” units.*		
Note: *Oxygen sensor types: Type 1 is a plasma-sprayed cell and is the standard cell. Type 2 is a coated plasma-sprayed cell intended for applications where percent levels of CO are expected.*		

7.5 Ordering Information (cont.)

The information below shows how the FGA 300D Part Number is configured from the options specified.

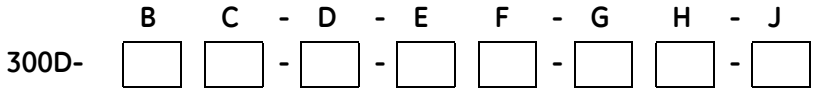

Table 24: FGA 300D Digital Display Ordering Information

LTR	CATEGORY	OPTIONS
B	**Package**	0 = No enclosure (OEM) 1 = Weatherproof enclosure (IP65) 2 = Rack mount 3 = Bench mount 4 = Panel mount 7 = Flameproof enclosure (II 2 G EEx d IIC T6) 8 = Flameproof enclosure with FTC (II 2 G EEx d IIC T6) 9 = 304SS Weatherproof enclosure (IP65) **S** = Special
C	**Power**	**1** = 100 VAC **2** = 110 / 120 VAC **3** = 220 VAC **4** = 240 VAC
D	**Analog Output Format**	**1** = 0-20mA output **2** = 4-20mA output **3** = 0-10 VDC output **S** = Special
E	**Zirconia Range** *Specify fuel and range	0 = None 1 = 0-5% Oxygen **2** = 0-10% Oxygen **3** = 0-20% Oxygen **4** = 0-25% Oxygen **5** = 0-1000mV - Cell mV **6** = 0.8-1.2/0.8-2.0 Air factor* **7** = 5/10/20/25% Excess fuel* **8** = 5/10/20/25% Equivalent combustibles* **S** = Special*
F	**Combustibles Range CO + H2**	**0** = None **1** = 0-2,000 ppm_v combustibles **2** = 0-5,000 ppm_v combustibles **3** = 0-10,000 ppm_v combustibles **4** = 0-2.00% combustibles **S** = Special
G	**Alarms**	**0** = Single oxygen and single combustibles alarm (standard configuration) **1** = Dual oxygen alarms **2** = Dual combustibles alarms

Table 24: FGA 300D Digital Display Ordering Information

LTR	CATEGORY	OPTIONS
H	Special	**0** = None **2** = Tropicalized **S** = Special
J	Temperature Control Setting**	**1** = 700°C (standard for 300H and 300HX) **S** = Special (please specify) **Temperature must match analyzer

The information below shows how the FGA Current Output Board Part Number is configured from the options specified.

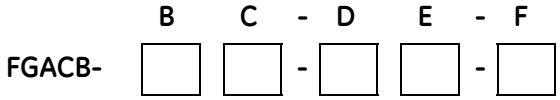

Table 25: FGA Current Output Board Ordering Information

LTR	CATEGORY	OPTIONS
B	Voltage	**1** = 100 VAC **2** = 110 VAC **3** = 220 VAC **4** = 240 VAC
C	Location	**1** = Supplied loose **2** = Mounted with furnace temperature control card **3** = Mounted in separate Weatherproof (IP65) enclosure **4** = Mounted in separate Explosion-Proof enclosure **S** = Special
D	Range	**1** = 0-1% Oxygen **2** = 0-5% Oxygen **3** = 0-10% Oxygen **4** = 0-20.9% Oxygen **5** = 0-25% Oxygen **S** = Special
E	Special	**0** = None **1** = 0-1V Output **2** = Tropicalized **S** = Special
F	Temperature Control Setting*	**0** = Factory selected option *Temperature must match analyzer

7.5 Ordering Information (cont.)

The information below shows how the FGA 300 Probe and Probe Sleeve Part Number is configured from the options specified.

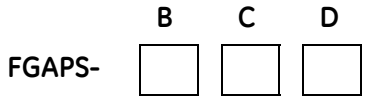

Table 26: FGA Probe and Probe Sleeve Ordering Information

LTR	CATEGORY	OPTIONS
B	**Temperature Range**	**1** = below 650°C **2** = 650° to 950°C **3** = 950° to 1600°C **4** = above 1600°C
C	**Sampling Method**	**1** = Standard sampling method **3** = Aspirated sampling method **S** = Special sampling method
D	**Nominal Length**	**1** = 0.6m long **2** = 1.0m long **4** = 1.4m long (see note) **S** = Special
Note: *The 1.4m length is normally only available for temperatures over 950°C (where* **B = 3** *or* **4***).*		
Note: *If the unit has an aspirator, choose* Sampling Method *option* **C = 3**, Aspirated.		

Appendix A. Rotary Switch Settings

A.1 Overview

The *Display Electronics Console* for the FGA 300H(X) analyzer is completely configured at the factory to meet the specified requirements. However, the instructions in this appendix may be used to complete the following adjustments:

- Selecting the Fuel Type
- Selecting the Display Parameter
- Adjusting the Oxygen Channel
- Adjusting the Combustibles Channel

CAUTION! **The display circuitry is factory set and should only be adjusted in the field by a fully qualified electronics technician. This appendix should be used as a reference for field personnel to make such adjustments.**

To make the first three adjustments above, use rotary switches S1, S2 and S3 on the upper portion of the 300D display printed circuit board. To access these switches, open the Display Console and refer to Figure 48 to locate the switches.

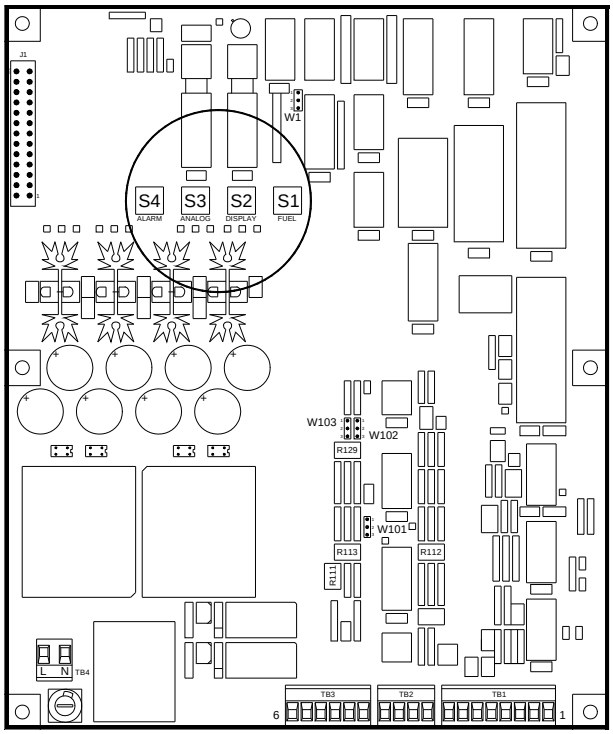

Figure 48: Rotary Switch Locations

Note: *For units fitted with the previous version of the 300D printed circuit board, see Appendix F,* Previous Configurations*, for the layout of this circuit board.*

For reconfiguration information not covered in this appendix, contact the factory for assistance.

A.2 Selecting the Display Parameter

Switch S2 allows the selection of the combustion process parameter to be automatically displayed.

Note: *The 300D can automatically display only one parameter at a time. Therefore, only the display parameter selected with switch S2 is automatically displayed.*

Refer to Table 27 and use switch S2 to select the preferred automatic display parameter.

Table 27: Rotary Switch S2 Settings

Position	Default Display Parameter
0	% Oxygen
1	% Excess Fuel
2	% Equivalent Combustibles
3	Air Factor
4	Combustibles Index
5	Sensor mV

A.3 Selecting the Fuel Type

Switch S1 allows the selection of the appropriate fuel type for installation. However, switch S1 is used in conjunction with switch S2, and it is applicable only to the following three display parameters (as chosen with switch S2):

- % Excess Fuel
- % Equivalent Combustibles
- Air Factor

If switch S2 is used to automatically display any other parameter, switch S1 has no effect. Use Table 28 to determine the correct setting for switch S1.

Table 28: Rotary Switch S1 Settings

Position	Fuel Type
0	Coal
1	Oil
2	Propane/Butane
3	Natural Gas
4	Coke Oven Gas

A.4 Adjusting the Oxygen Channel

While switch S2 is used to select the parameter displayed, switch S3 permits selection of the analog output range for the parameter being displayed. Since switch S3 is used in conjunction with switch S2, the analog output range is determined by the S2/S3 combination chosen.

Note: *The analog output range may only be adjusted for the oxygen channel, not the combustibles channel.*

To better understand the interaction between switches S2 and S3, consider the following two examples:

- **switch S2=0 and switch S3=1:**
  The S2 setting causes percent oxygen to be displayed and the S3 setting specifies an offset analog output of 4-20 mA/2-10 V to represent an oxygen range of 0-5% (see Table 30 on page 120).
- **switch S2=3 and switch S3=1:**
  The S2 setting causes air factor to be displayed and the S3 setting specifies an offset analog output of 4-20 mA/2-10 V to represent an air factor of 0.8-2.0 (see Table 31 on page 120).

For other S2/S3 combinations, refer to Figure 48 on page 117 and follow the directions in Table 29 to set the oxygen channel analog output range (either zero-based or offset) with switch S3.

Table 29: Switch S2 Settings

If Switch S2 =:	Go To:
Position 0 (% oxygen)	Table A-4
Position 1 (% excess Fuel)	Table A-4
Position 2 (% equivalent combustibles)	Table A-4
Position 3 (air factor)	Table A-5
Position 4 (combustibles index)	Table A-6
Position 5 (sensor mV)	Table A-7

A.4 Adjusting the Oxygen Channel (cont.)

Use Table 30 to determine the switch S3 setting, if switch S2 is set to position 0, 1 or 2.

Table 30: Switch S3 Settings (S2=0, 1, 2)

Position	Analog Output Range
0	0-5% (0-20 mA/0-10 V)
1	0-5% (4-20 mA/2-10 V)
2	0-10% (0-20 mA/0-10 V)
3	0-10% (4-20 mA/2-10 V)
4	0-15% (0-20 mA/0-10 V)
5	0-15% (4-20 mA/2-10 V)
6	0-20% (0-20 mA/0-10 V)
7	0-20% (4-20 mA/2-10 V)
8	0-25% (0-20 mA/0-10 V)
9	0-25% (4-20 mA/2-10 V)

Use Table 31 to determine the switch S3 setting, if switch S2 is set to position 3.

Table 31: Switch S3 Settings (S2=3)

Position	Analog Output Range
0	0.8-2.0 (0-20 mA/0-10 V)
1	0.8-2.0 (4-20 mA/2-10 V)

Use Table 32 to determine the switch S3 setting, if switch S2 is set to position 4.

Table 32: Switch S3 Settings (S2=4)

Position	Analog Output Range
0	7.0-14.1 (0-20 mA/0-10 V)
1	7.0-14.1 (4-20 mA/2-10 V)

Use Table 33 to determine the switch S3 setting, if switch S2 is set to position 5.

Table 33: Switch S3 Settings (S2=5)

Position	Analog Output Range
0	0-1000 mV (0-20 mA/0-10 V)
1	0-1000 mV (4-20 mA/2-10 V)

A.5 Adjusting the Combustibles Channel

The following two adjustments can be made to the combustibles channel of the Display Console:

- Setting the scale type (zero-based or offset)
- Setting the Zero and Full Scale Values

A.5.1 Setting the Scale Type

Each unit is shipped with the analog outputs set up as specified at the time of purchase. However, the analog outputs can be changed to be either a zero-based or offset scale, using the following procedures:

Note: *The zero and full scale analog output values must be set after selecting a linear or offset scale.*

Specify the desired scale type by installing jumper W103 in one of the following positions (see Figure 49 on page 122):

- position 1/2 for a linear scale (0-20 mA or 0-10 V), or
- position 2/3 for an offset scale (4-20 mA or 2-10 V)

A.5.2 Setting the Zero and Full Scale Values

Setting the zero and full scale values is the second step in setting up the analog outputs. Please keep in mind that the scale type (zero-based or offset) should be selected before setting the zero and full scale values. Since the procedures for the two scale types are different, proceed to the appropriate section to set the output values (refer to Figure 49 on page 122).

A.5.2a A Linear Scale

To set the zero and full scale values for a linear scale, complete the following steps (see Figure 49 on page 122):

1. Connect two identical resistors of between 1800 and 2000 ohms across terminal block TB1 pins 5-6 and pins 6-7.

2. Install a jumper on pins 1 and 2 of W103.

3. Adjust potentiometer R111 for the desired full scale value, as read on the front panel display.

4. Adjust potentiometer R129 until the analog output corresponds to the value on the front panel display.

5. Remove the resistors from TB1 and the jumper from W103.

Note: *For units fitted with the previous version of the 300D printed circuit board, see Appendix F,* Previous Configurations*, for the layout of this circuit board.*

A.5.2 Setting the Zero and Full Scale Values (cont.)

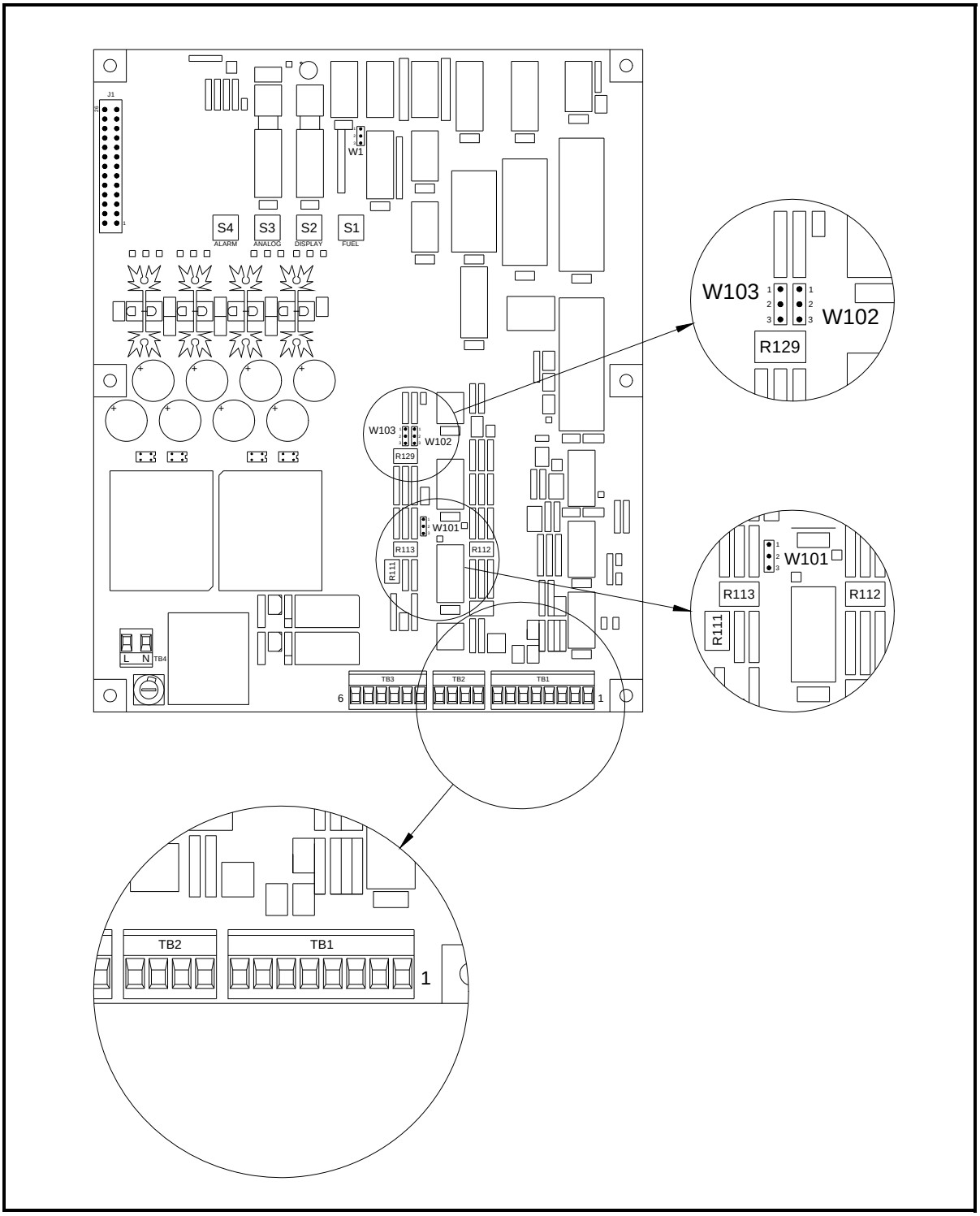

Figure 49: Combustibles Adjustment Components

A.5.2b An Offset Scale

To set the zero and full scale values for an offset scale, complete the following steps (see Figure 49 on page 122):

1. Connect two identical resistors of between 1800 and 2000 ohms across terminal block TB1 pins 5-6 and pins 6-7.
2. Install a jumper on pins 2 and 3 of W103.
3. Adjust potentiometer R111 for a zero value, as read on the front panel display.
4. Attach the positive (+) lead of a multimeter to pin 3 of terminal block TB2 and attach the negative (-) lead of the multimeter to pin 4 of terminal block TB2. Then, adjust potentiometer R112 until a reading of 4 mA (or 2 V) is obtained.
5. Adjust potentiometer R111 for the desired full scale value, as read on the front panel display.
6. Adjust potentiometer R129 until the analog output corresponds to the value on the front panel display.
7. Remove the resistors from TB1 and the jumper from W103.

[no content intended for this page]

Appendix B. Outline and Mounting Dimensions

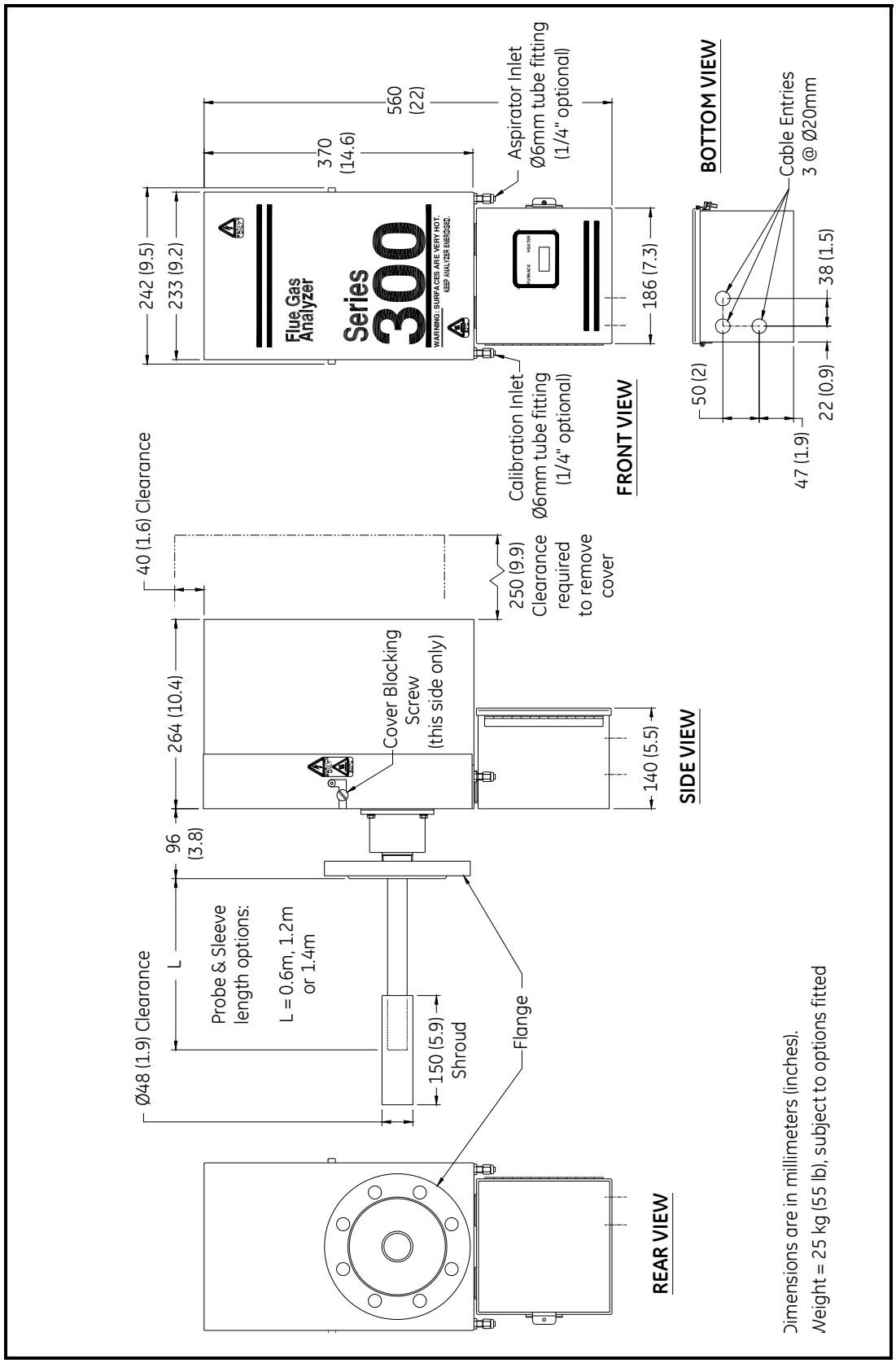

Figure 50: Main Analyzer Unit - Standard (Weatherproof)

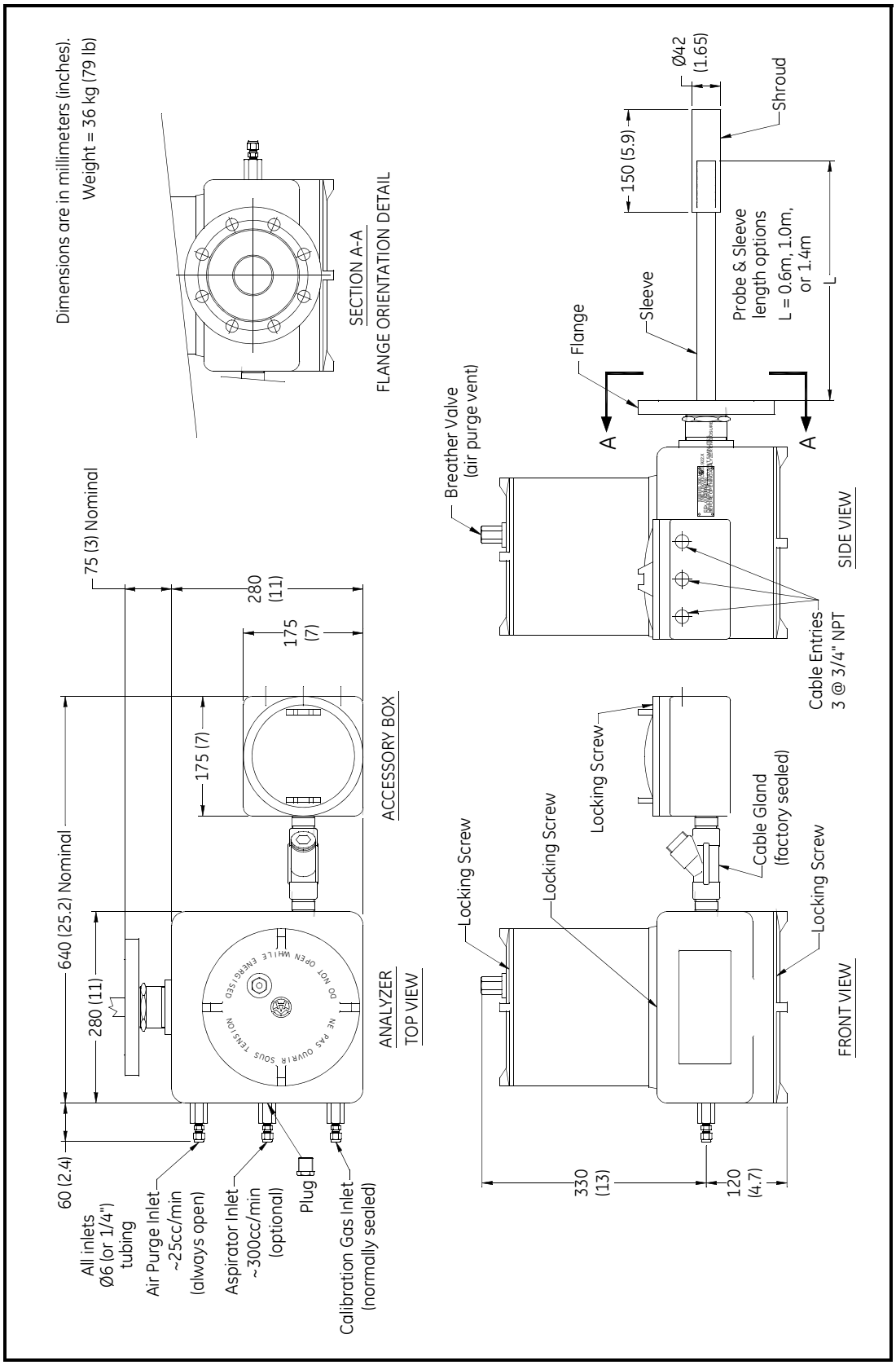

Figure 51: Main Analyzer Unit (1 of 2) - Explosion-Proof (Flameproof)

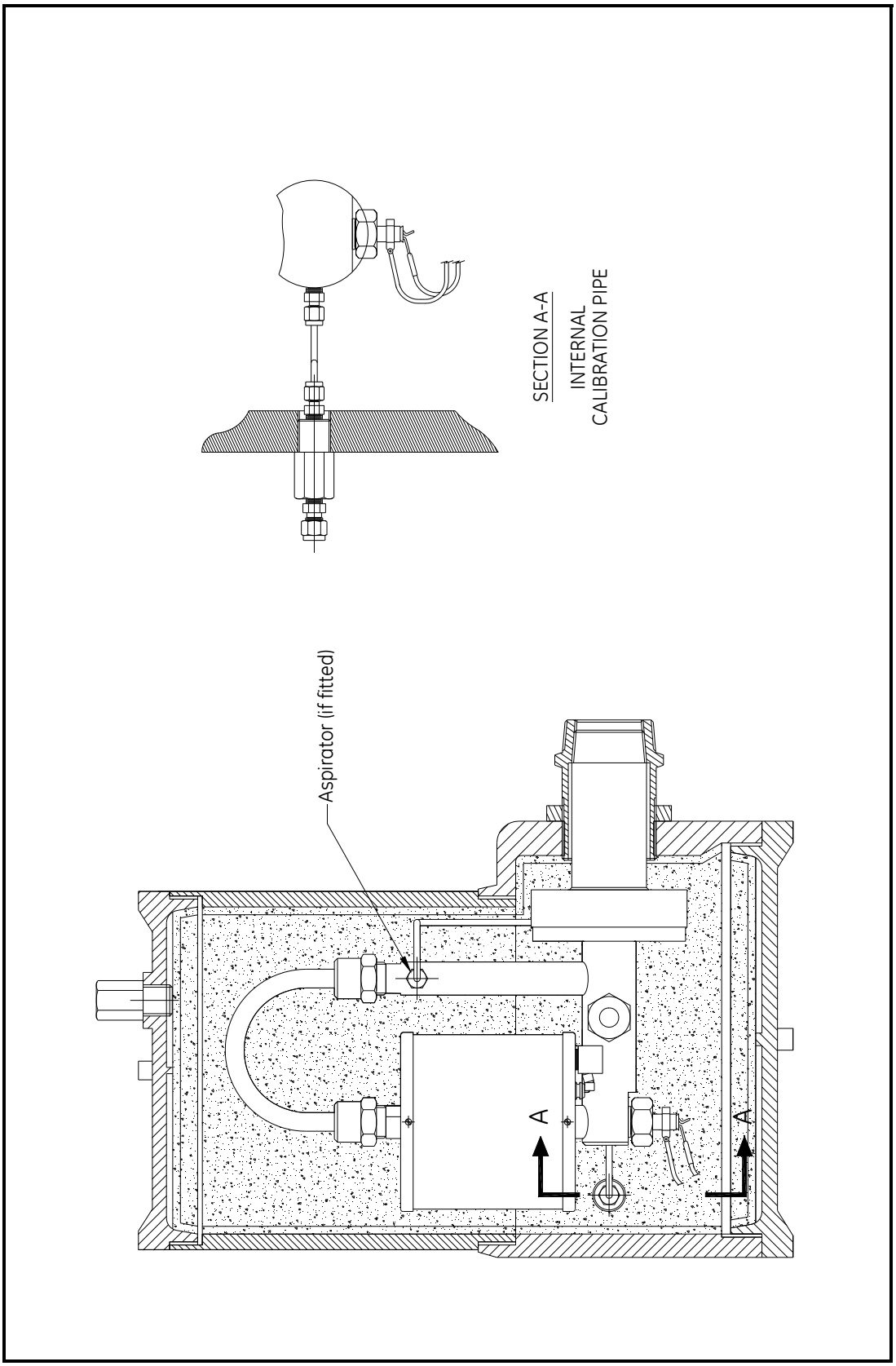

Figure 52: Main Analyzer Unit (1 of 2) - Explosion-Proof (Flameproof)

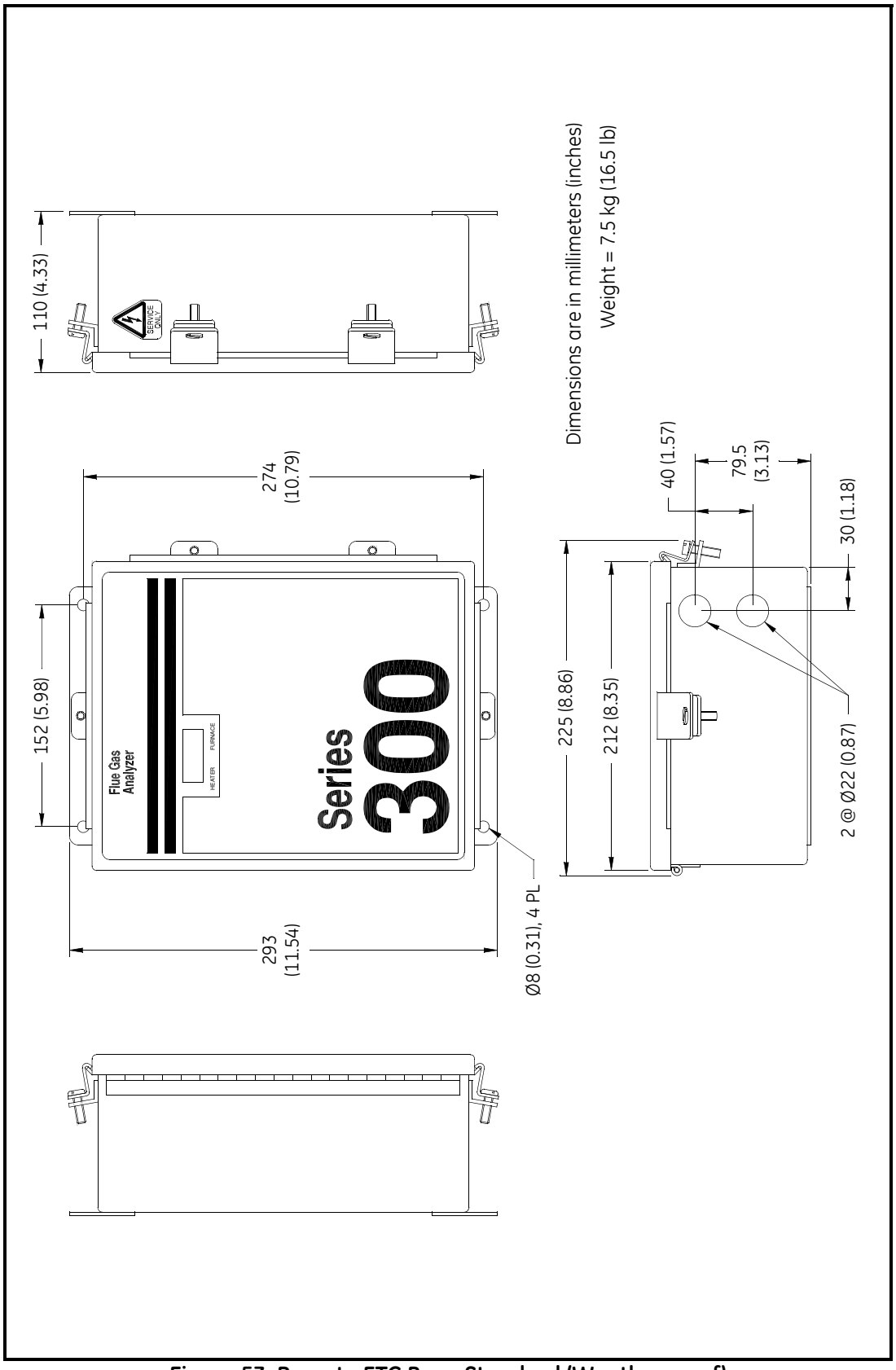

Figure 53: Remote FTC Box - Standard (Weatherproof)

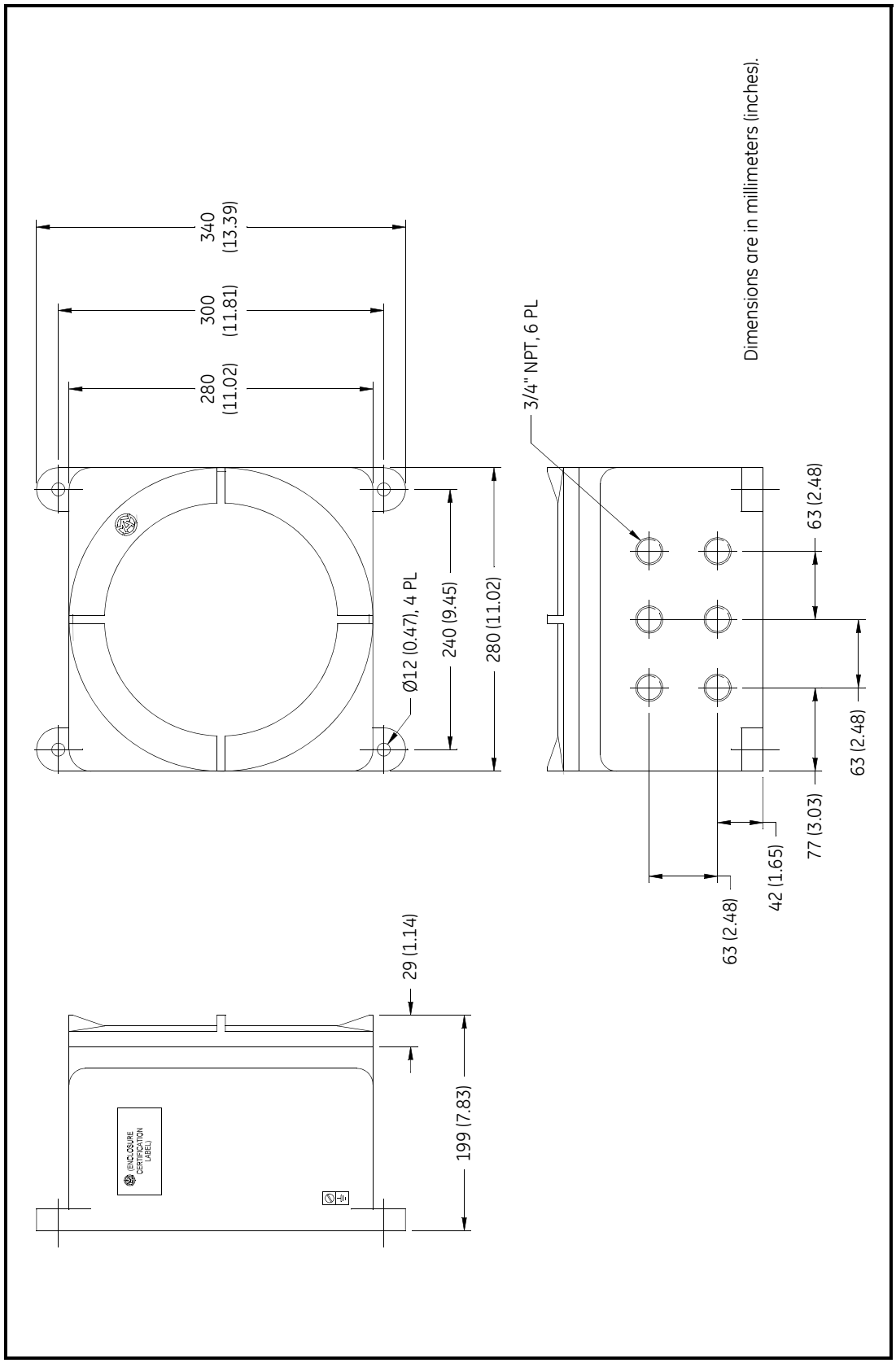

Figure 54: Main Analyzer Unit (1 of 2) - Explosion-Proof (Flameproof)

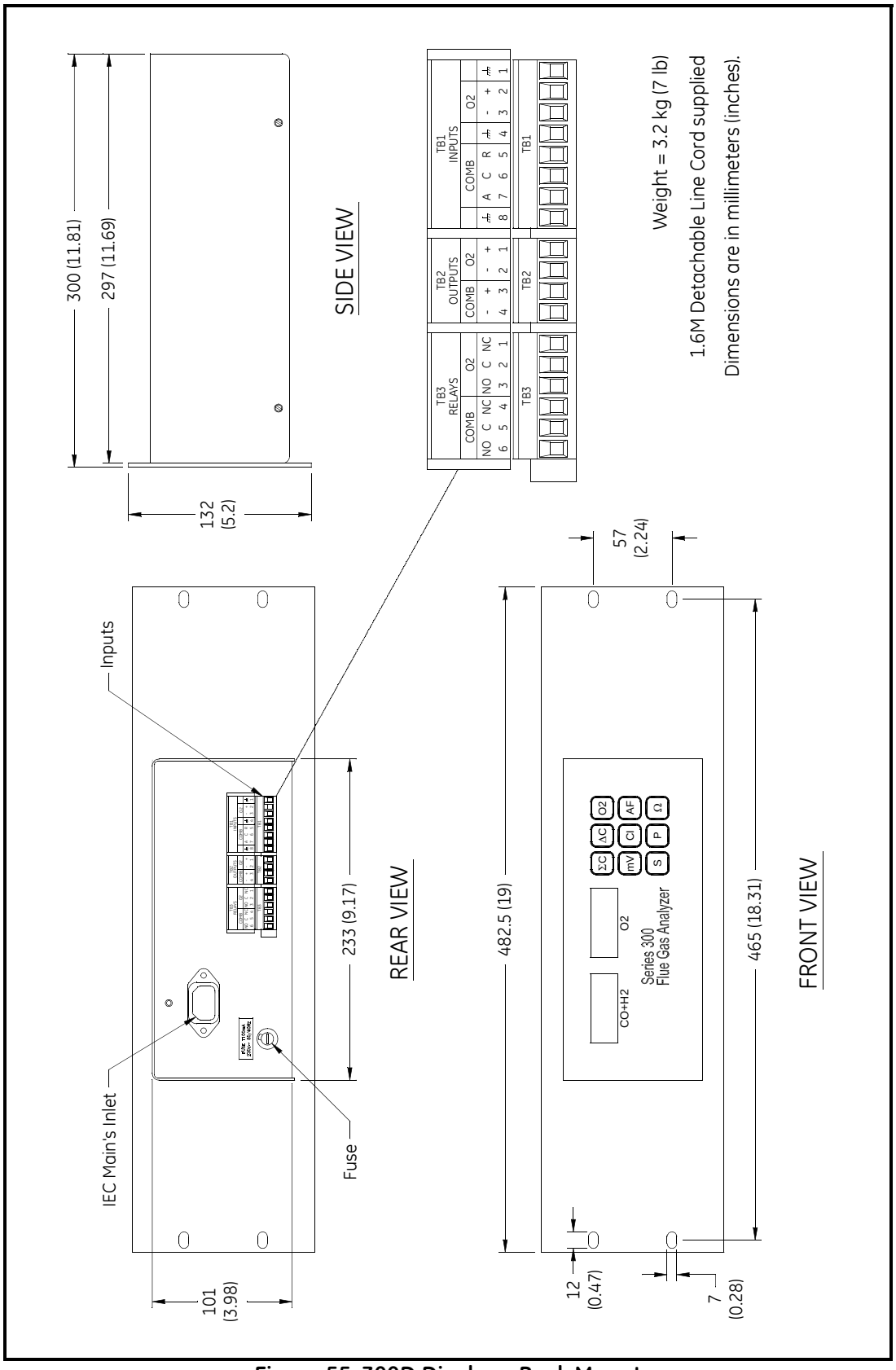

Figure 55: 300D Display - Rack Mount

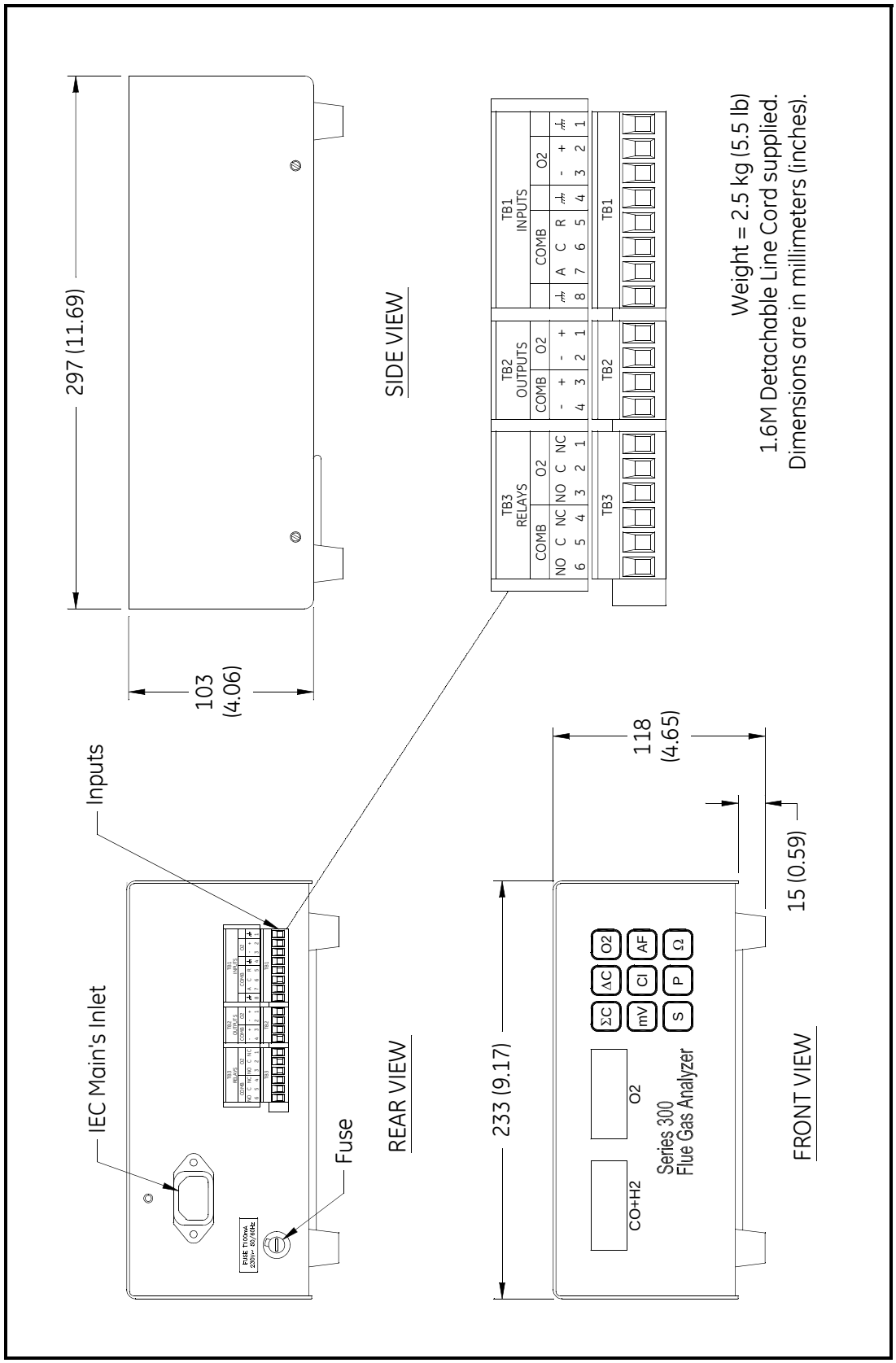

Figure 56: 300D Display - Bench Mount

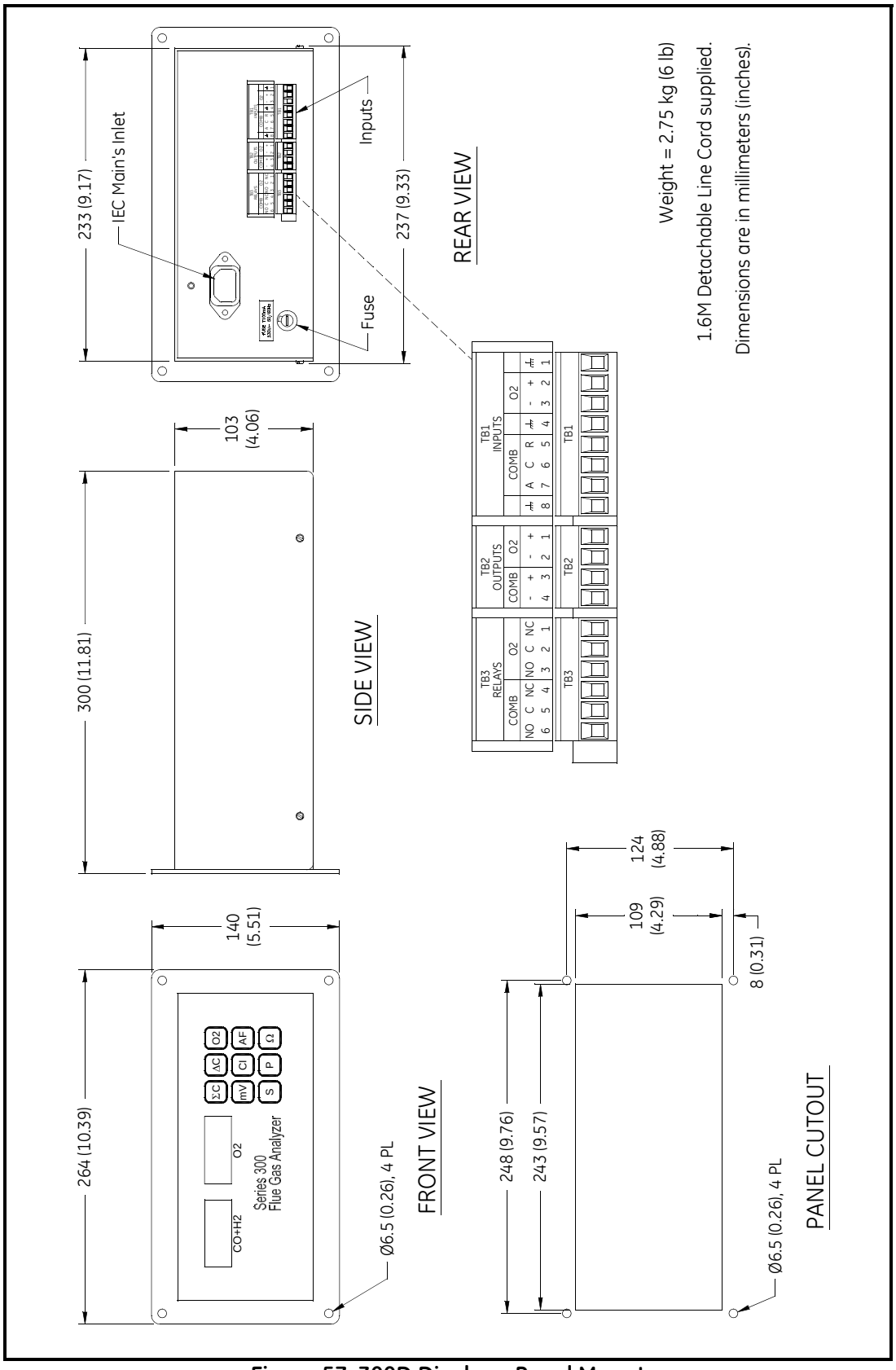

Figure 57: 300D Display - Panel Mount

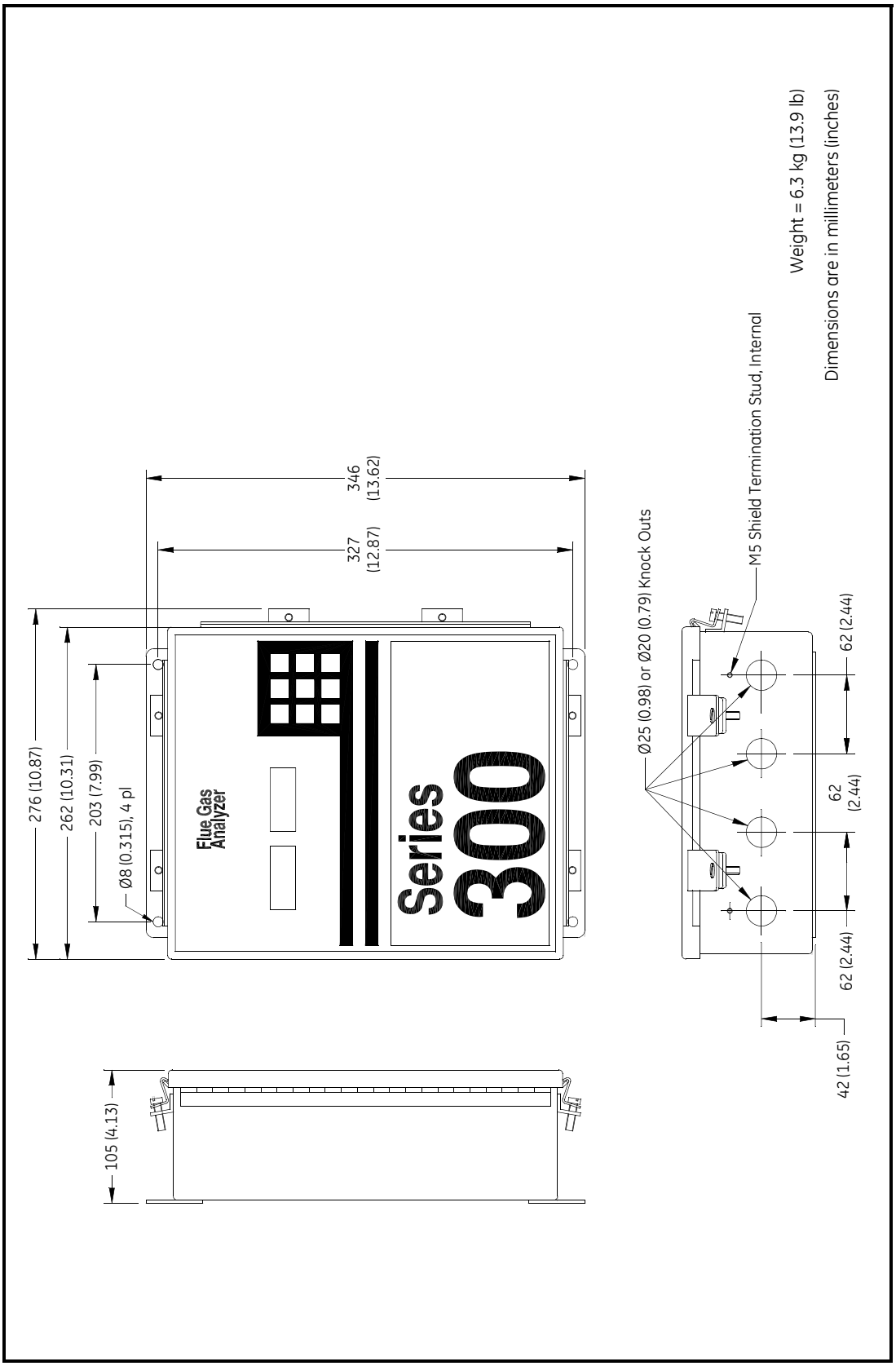

Figure 58: 300D Display - Standard (Weatherproof)

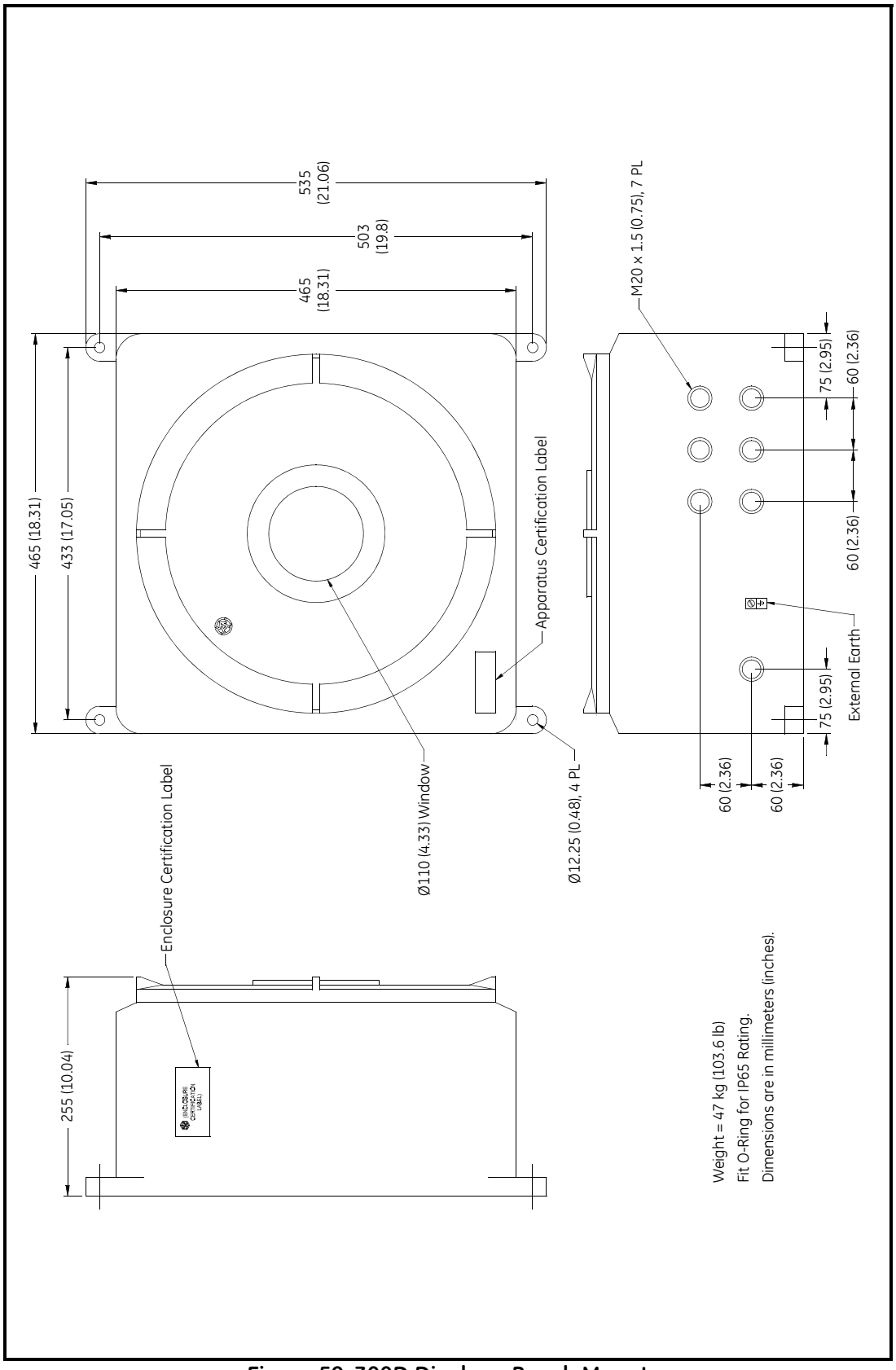

Figure 59: 300D Display - Bench Mount

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Appendix C. The Nernst Equation

C.1 Overview

The FGA 300H(X) uses the *Nernst Equation* to calculate the oxygen content of the flue gas. When a Yttrium-doped zirconium oxide ceramic is heated to a temperature above 650 °C, it becomes an electrolytic conductor, as vacancies in the crystal lattice permit oxygen ions to diffuse into the ceramic.

If there are different oxygen partial pressures on the two sides of the ceramic cell, oxygen ions will migrate along the resulting *concentration gradient*. This constitutes a transfer of electrons from one face of the ceramic to the other. If the transferred charge is allowed to accumulate, it gives rise to a *potential gradient* acting in the opposite direction, thus tending to oppose further diffusion.

C.2 Equilibrium Conditions

Under equilibrium conditions, the potential gradient exactly balances the concentration gradient. Porous coatings of a platinum catalyst on both surfaces of the ceramic cell serve as electrodes, while still allowing the oxygen molecules to penetrate the coating and diffuse into the ceramic. The measured voltage drop across the cell can be directly related to the ratio of the two oxygen partial pressures by means of the *Nernst Equation*:

$$E_{12} = \frac{RT}{nF} \bullet \ln\left[\frac{p_1}{p_2}\right]$$

where,

F = the Faraday = 96,484.56 coulombs

T = absolute temperature = °K (°K = °C + 273.15°)

R = gas constant = 8.31441 volt-coulomb/mole-°K

n = # electrons transferred per molecule = 4/mole

ln = natural logarithm = 2.303 $\log_{10}$

p_1 = O_2 partial pressure on reference gas side = 0.209

p_2 = O_2 partial pressure on flue gas side

E_{12} = voltage on reference face with respect to the flue gas face

C.3 The FGA 300H(X) Equations

The Nernst Equation specifically applicable to the FGA 300H(X) is obtained by substituting the above values into the general equation, converting the natural logarithm to the common logarithm (base 10) and converting the units for E_{12} to millivolts. This results in the following equation:

$$E_{12}(mV) = 0.049605 \bullet T \bullet \log\left[\frac{0.209}{p_2}\right]$$

The FGA 300H(X) measures the temperature of the oxygen sensor and automatically inserts the correct value into the Nernst Equation. For example, at the standard oxygen sensor operating temperature of 700°C, the above equation becomes:

$$E_{12}(mV) = 48.273 \bullet \log\left[\frac{0.209}{p_2}\right]$$

The voltage drop across the zirconium oxide sensor, as calculated from the Nernst equation, is then sent to the linearizer circuit. The circuit produces a linear analog output that represents the percentage of oxygen in the flue gas, and this signal is available as a recorder output at pins 1 and 2 of terminal block TB2 on the Display Console circuit board.

For convenience, the standard Nernst equation for the FGA 300H(X) above has been converted into a graphical format. Use this graph (see Figure 60 on page 139) to quickly correlate the analog output voltage reading with the corresponding oxygen percentage, at the operating temperature of the unit.

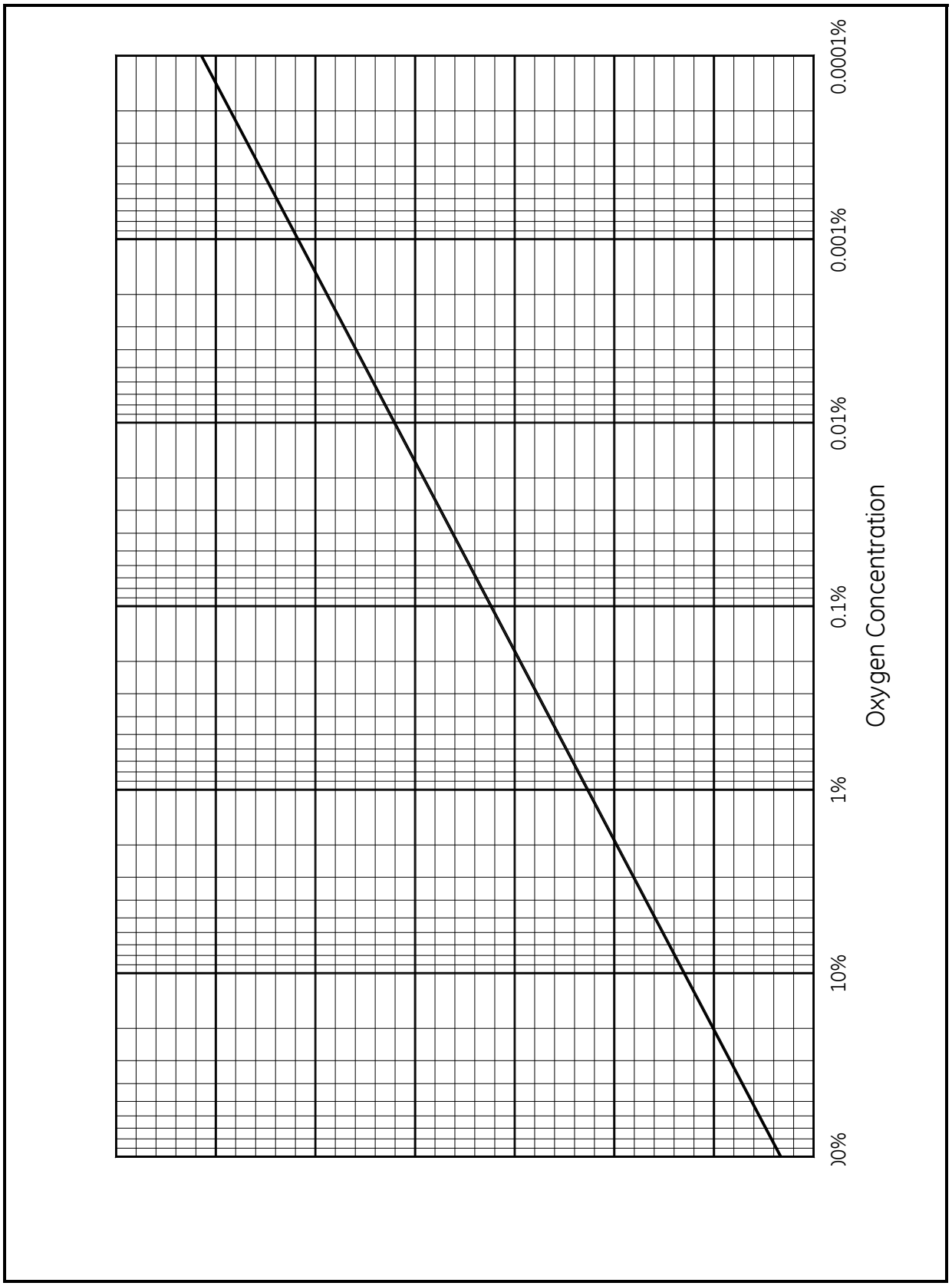

Figure 60: Oxygen Sensor Output at 700°C

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Appendix D. Wiring Diagrams and Circuit Boards

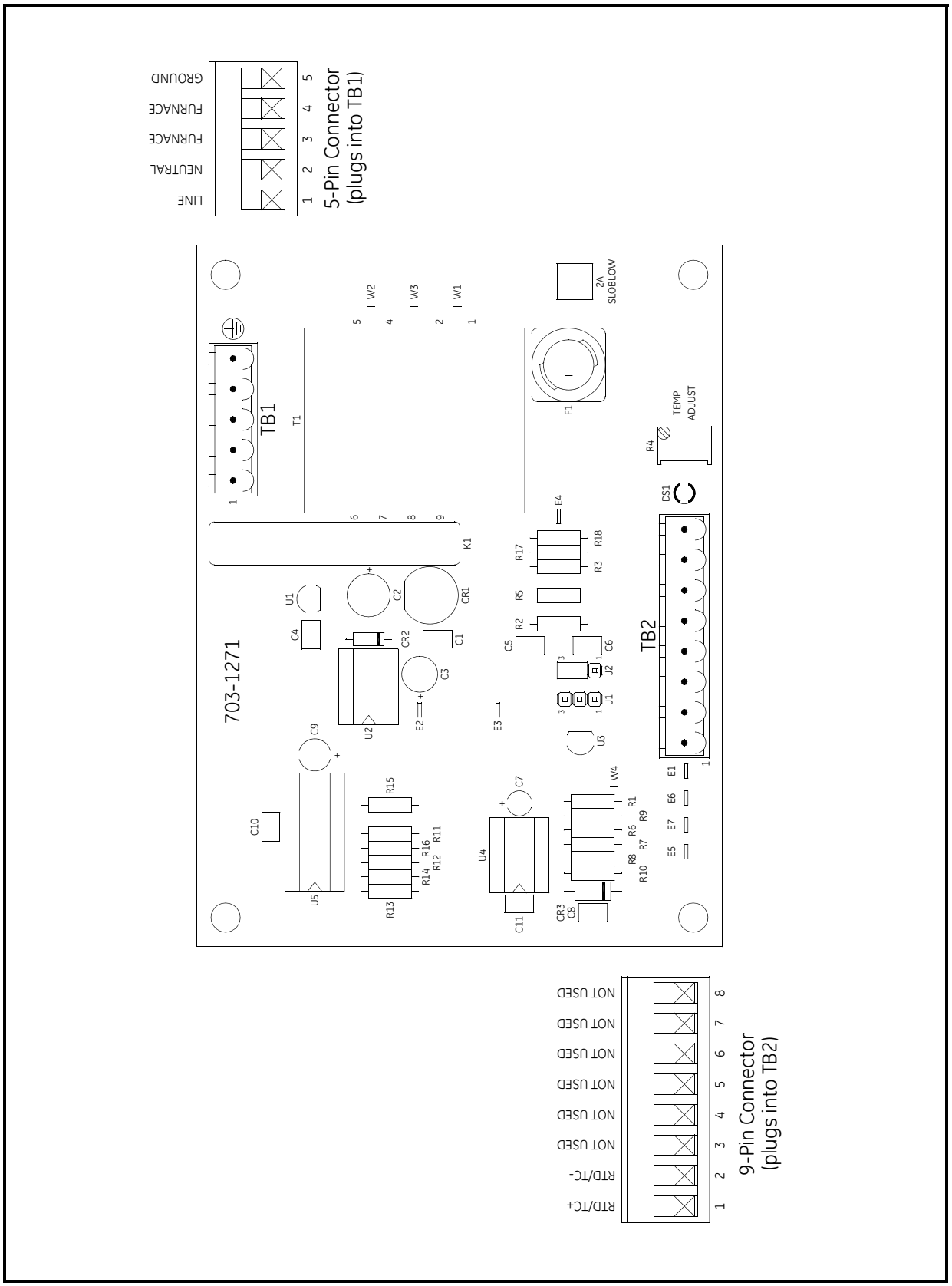


Figure 61: FTC Circuit Board - Current (ref. dwg #703-1271)

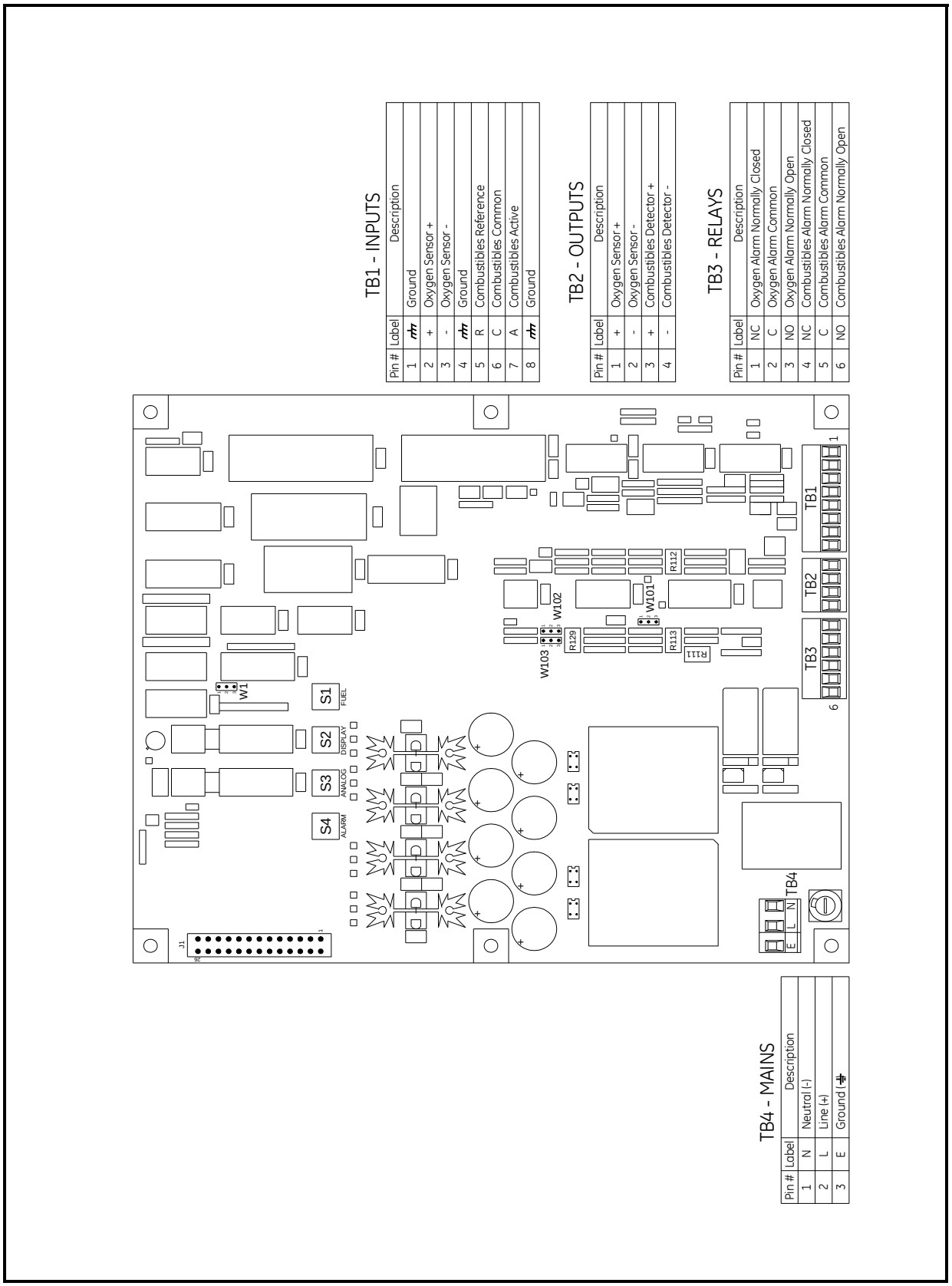

TB1 - INPUTS
Pin # | Label | Description
1 | ⏚ | Ground
2 | + | Oxygen Sensor +
3 | - | Oxygen Sensor -
4 | ⏚ | Ground
5 | R | Combustibles Reference
6 | C | Combustibles Common
7 | A | Combustibles Active
8 | ⏚ | Ground
TB2 - OUTPUTS
Pin # | Label | Description
1 | + | Oxygen Sensor +
2 | - | Oxygen Sensor -
3 | + | Combustibles Detector +
4 | - | Combustibles Detector -
TB3 - RELAYS
Pin # | Label | Description
1 | NC | Oxygen Alarm Normally Closed
2 | C | Oxygen Alarm Common
3 | NO | Oxygen Alarm Normally Open
4 | NC | Combustibles Alarm Normally Closed
5 | C | Combustibles Alarm Common
6 | NO | Combustibles Alarm Normally Open
TB4 - MAINS
Pin # | Label | Description
1 | N | Neutral (-)
2 | L | Line (+)
3 | E | Ground (⏚)
TB1
TB2
TB3
TB4
E L N
J1
W1
W101
W102
W103
R112
R113
R123
R111
S1 FUEL
S2 DISPLAY
S3 ANALOG
S4 ALARM

Figure 62: Display Circuit Board - Current (Drawing #1703-011)

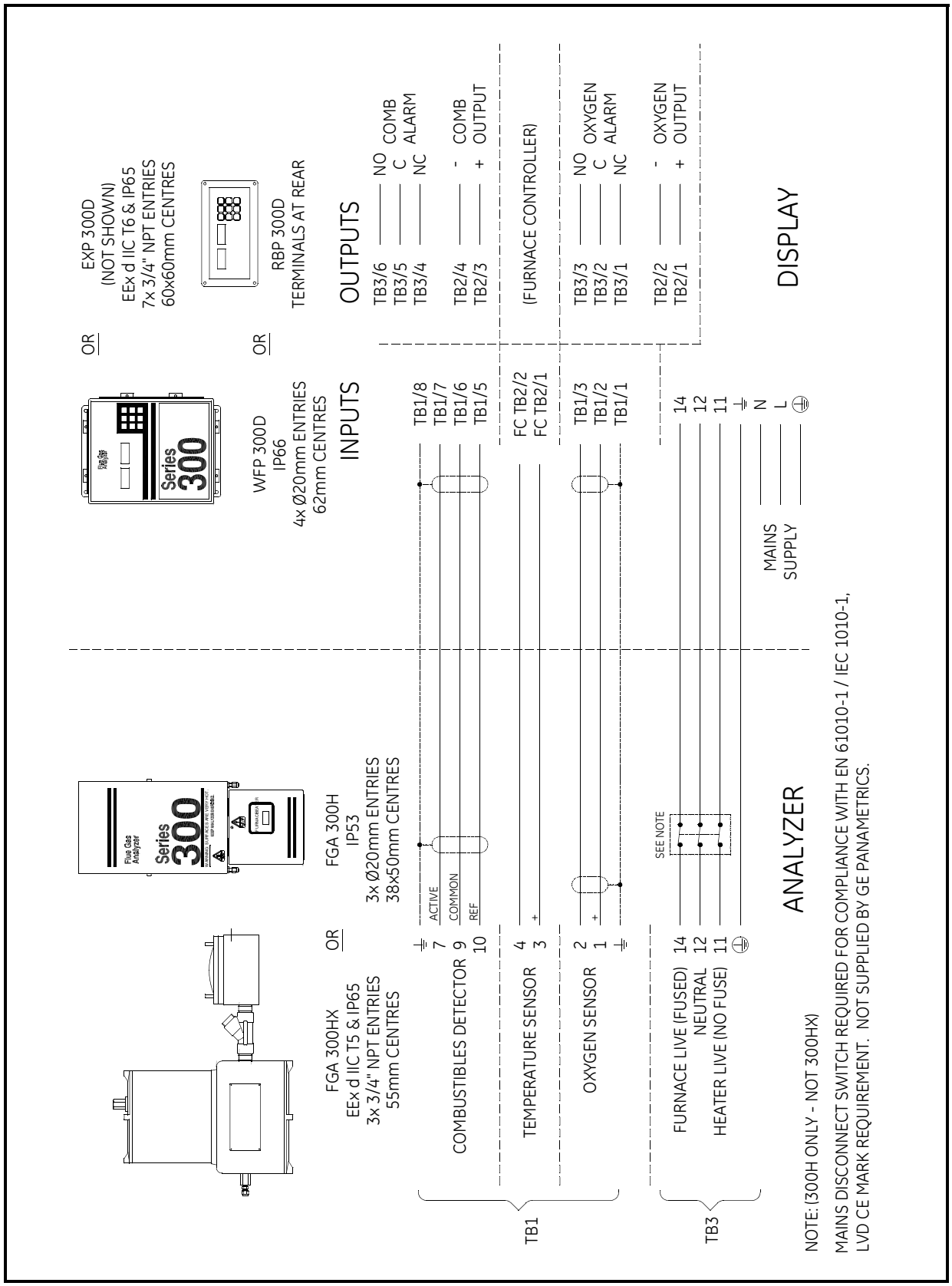


Figure 63: Interconnection Diagram with FTC Board in Display Enclosure

Appendix E. Default Settings

E.1 Overview

For CE Mark compliance, the FGA 300**H** must meet both the *EMC* and *LVD* directives. The FGA 300**HX** must meet only the *EMC* directive.

IMPORTANT: *CE Mark compliance is required only for units used in EEA countries.*

IMPORTANT: *For EN 61000-4-3, the FGA 300H(X) meets Performance Criterion A, except at a limited number of frequencies, Criterion B, per EN 61326.*

E.2 EMC Compliance

For *EMC* compliance, the electrical connections must be shielded and grounded as shown in Table 34. After all the necessary electrical connections have been made, seal any unused cable entry holes with standard conduit plugs or equivalent.

Note: *If the instructions in this appendix are followed, the unit will comply with the EMC Directive 89/336/EEC.*

Table 34: Wiring Modifications for EMC Compliance

Connection	Wiring Modification
Power	1. Use shielded* cable to connect power to the FGA 300H(X). 2. Select the cable entry closest to the chassis ground. 3. Connect the power line ground wire and the shield* to the nearest chassis ground terminal.
Input/Output	1. Use shielded* cable to interconnect the FGA 300H(X) with any external input/output devices. 2. Connect the shields* to the nearest chassis ground terminal.
*Wires installed in properly grounded metal conduit are not required to have their own shield.	

E.3 LVD Compliance

For compliance with the European Union's Low Voltage Directive (73/23/EEC), the analyzer requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the FGA 300H. Because the sensor furnace power feed in the remote FTC Box must also be interrupted, a 4-pole disconnect device is required.

Note: *If the instructions in this appendix are followed, the unit will comply with the Low Voltage Directive (73/23/EEC).*

[no content intended for this page]

Appendix F. Previous Configurations

F.1 Overview

Over the years, feedback from field installations and advancements in technology have led to refinements in the furnace temperature control (FTC) circuitry of the FGA 300H(X) analyzer. Specifically, the following components within the remote FTC Box have evolved:

- FTC printed circuit board
- sensor furnace power transformer

Because of the reliability of the FGA 300H(X), many units with the previous FTC circuitry designs are still in use. Therefore, troubleshooting and replacement procedures for FTC units fitted with a transformer or a previous version of the FTC circuit board are presented in this appendix.

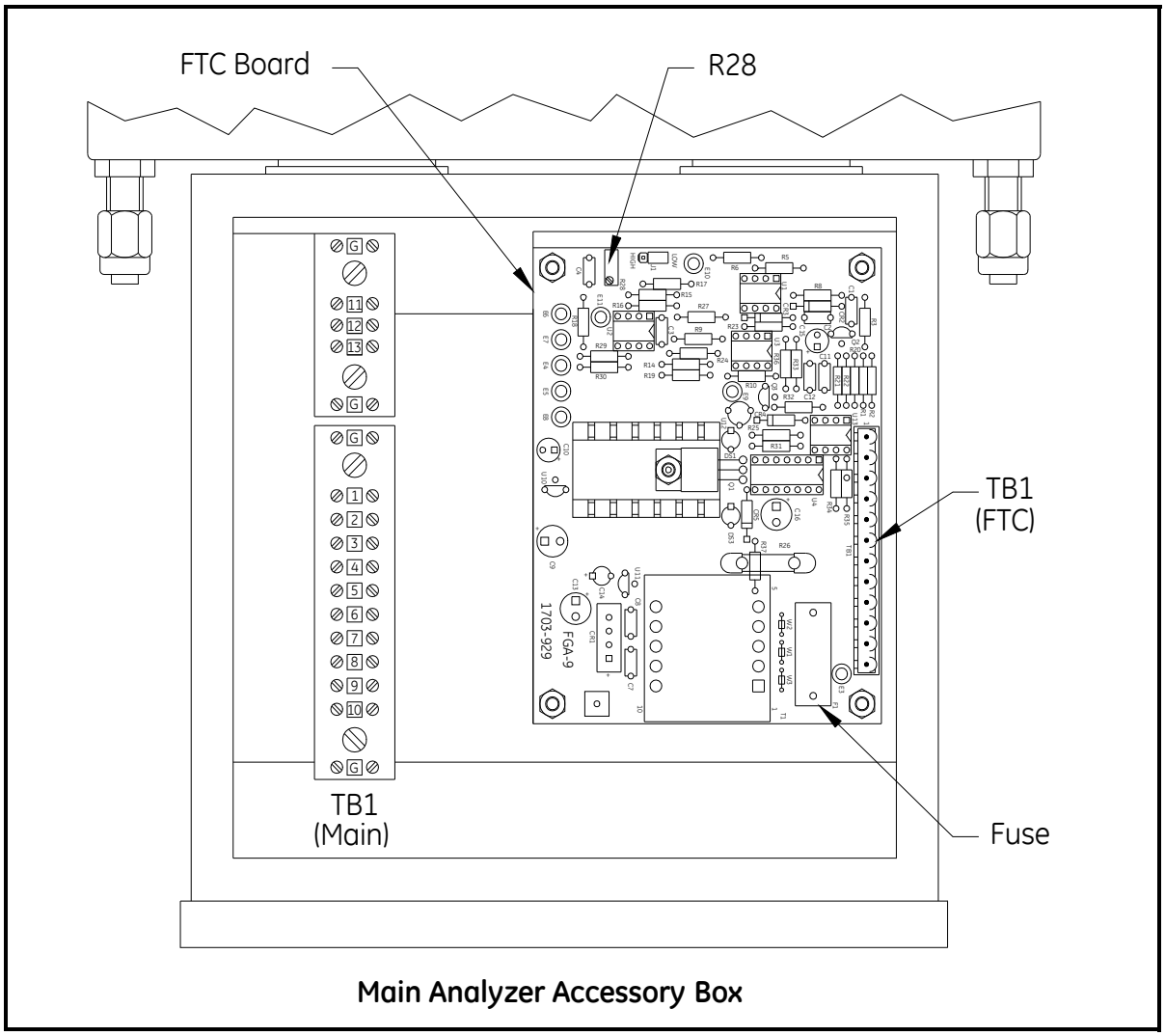


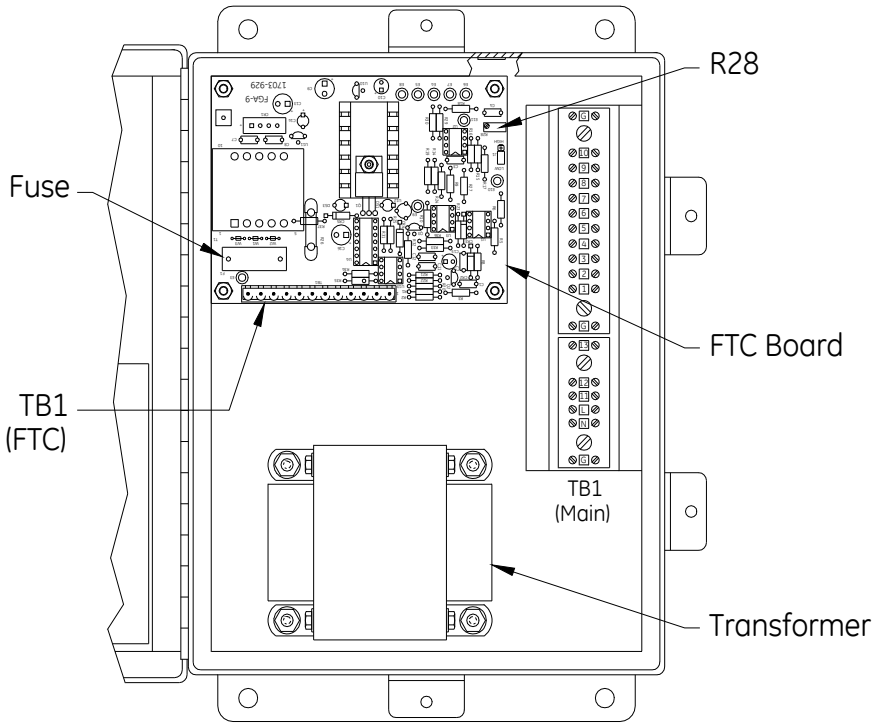
Figure 64: Local FTC Board - Previous Version

F.2 Testing the FTC Board and Transformer

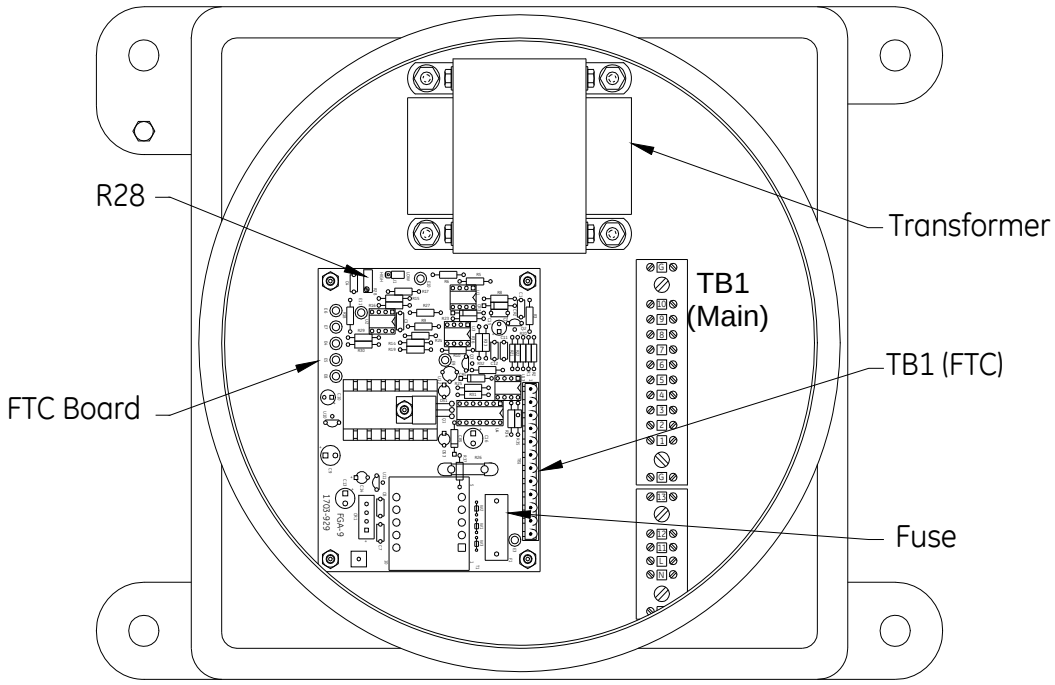
If the standard testing procedures in Chapter 5, *Troubleshooting*, reaches the point where the FTC circuit board must be checked, refer to Figure 64 on page 147 for local wiring, or Figure 65 on page 149 for a remote setup, and complete the following steps:

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

1. Open the hinged cover on the standard Accessory Box or on a standard (weatherproof) FTC box. For an explosion-proof (flameproof) FTC box, loosen the locking set screw on top of the FTC box and, using a long screwdriver across the slots provided, unscrew the cover from the enclosure.
2. Using a digital multimeter, measure the voltage across pins 5 and 6 on terminal block TB1 in the FTC/Accessory Box (**NOT** on the FTC board). If the reading is approximately 80 VAC, the FTC board and the transformer are functioning properly. If the reading is not approximately 80 VAC, proceed to the next step.
3. Measure the voltage across pins 10 and 11 on the FTC circuit board (**NOT** on TB1 of the FTC/Accessory Box). If the reading is not approximately line voltage, check the main power, as there is no power reaching the FTC board. If the reading is approximately line voltage, proceed to the next step.
4. Measure the voltage across pins 8 and 9 of terminal block TB1 on the FTC board (transformer input). If the reading is approximately line voltage proceed to the next step. If the reading is not approximately line voltage, replace the fuse on the FTC board (see the instructions later in this appendix).
5. Measure the voltage across pins 6 and 7 of terminal block TB1 on the FTC board (transformer output). If the reading is approximately 80 VAC, the FTC board is defective and must be replaced. If the voltage is not approximately 80 VAC, the transformer is defective and must be replaced. (Refer to the instructions later in this appendix for the correct replacement procedures.)



Standard (Weatherproof) FTC Box



Explosion-Proof (Flameproof) FTC Box

Figure 65: Remote FTC Board & Transformer - Previous Version

F.3 Replacing the FTC Board Fuse

The Furnace Temperature Control (FTC) fuse is located on the FTC board.

CAUTION! **To replace the FTC board fuse, the power to the FGA 300H(X) must be disconnected. Therefore, replace the FTC board fuse and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

The only tool needed to replace the FTC board fuse is a small screwdriver. Refer to Figure 64 on page 147 for local FTC, or Figure 65 on page 149 for remote FTC, and complete the following steps to replace the FTC board fuse:

1. Disconnect the main power to the FGA 300H(X).
2. Open the hinged cover on the standard Accessory Box or on a standard (weatherproof) remote FTC box. For an explosion-proof (flameproof) remote FTC box, loosen the locking set screw on top of the FTC box and, using a long screwdriver across the slots provided, unscrew the cover from the enclosure.
3. Locate the fuseholder on the FTC board. Using a small screwdriver, remove the spring-loaded cover from the fuseholder and discard the old fuse.
4. Install a new fuse of the same type and size (see Chapter 7, *Specifications*), and reinstall the fuseholder cover.
5. Close/reinstall the cover on the FTC Box and reconnect the main power to the system.

The system may now be placed back into service.

F.4 Replacing the FTC Board

The Furnace Temperature Control (FTC) board is located either in the Accessory Box or in a remote FTC box. The FTC board is a 3.5 x 4.7 in. (90 x 120 mm) rectangular printed circuit board that maintains a steady sensor furnace temperature in order to ensure accurate operation of the oxygen sensor.

CAUTION! **To replace the FTC board, the power to the FGA 300H(X) must be disconnected. Therefore, replace the FTC board and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

The only tool needed to replace the FTC board is a nutdriver or similar tool. Refer to Figure 64 on page 147 for local FTC or to Figure 65 on page 149 for remote FTC and complete the following steps to replace the FTC board:

1. Disconnect the main power to the FGA 300H(X).
2. Open the hinged cover on the standard Accessory Box or on a standard (weatherproof) remote FTC box. For an explosion-proof (flameproof) remote FTC box, loosen the locking set screw on top of the FTC box and, using a long screwdriver across the slots provided, unscrew the cover from the enclosure.
3. Remove the connector from the 12-pin terminal block (TB1) on the FTC circuit board.
4. Remove the four hex nuts and washers located in the corners of the old FTC board, and lift the FTC board out of the enclosure.

Note: *Install the new FTC board in the same orientation as the old FTC board. The line voltage for the new FTC board is factory set, based on the unit's serial number.*

5. Locate the new FTC board over the standoffs in the enclosure. Make sure that the new FTC board is in the same orientation as the old board and not rotated by 180°.
6. Replace the four hex nuts and washers in the corners of the new FTC board, and tighten the nuts securely.
7. Reconnect the connector to the 12-pin terminal block (TB1) on the new FTC circuit board.
8. Close/reinstall the cover on the FTC Box and reconnect the main power to the system.
9. Refer to Chapter 4, *Calibration*, and recalibrate the oxygen sensor and the combustibles detector.

This completes the replacement of the FTC board.

F.5 Replacing a Local Transformer

In a local FTC setup, the sensor furnace power transformer is located behind the FTC board in the Accessory Box. Its purpose is to convert the line voltage to the 80 VAC required for proper operation of the sensor furnace.

CAUTION! **To replace the transformer, the power to the FGA 300H(X) must be disconnected. Therefore, replace the transformer and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

The following items are needed to replace the transformer:

- A nutdriver (or similar tool)
- A screwdriver
- a digital multimeter

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

Refer to Figure 64 on page 147 and complete the following steps to replace the transformer:

1. Disconnect the main power to the FGA 300H(X).
2. Open the hinged cover on the Accessory Box.
3. Remove the connector from the 12-pin terminal block (TB1) on the FTC circuit board.
4. Remove the four hex nuts and washers located in the corners of the FTC board, and lift the FTC board out of the enclosure.

F.5 Replacing a Local Transformer (cont.)

5. Remove the FTC mounting plate by removing the four screws on the right and left side of the plate.

6. Remove the four hex nuts and washers from the old transformer.

7. Move the old transformer aside (do not disconnect any wires yet) and place the new transformer into the accessory box.

8. Disconnect the leads from the old transformer, one at a time, and connect the corresponding lead from the new transformer in its place, until all of the new leads have been connected.

9. Verify that the new transformer leads are properly connected by referring to Figure 68 on page 158.

10. Remove and discard the old transformer in accordance with local regulations.

11. Secure the new transformer in place with the four hex nuts and washers that were previously removed.

12. Reinstall the FTC mounting plate.

13. Reinstall the FTC board.

14. Reconnect the 12-pin connector to the FTC board.

15. Reconnect the main power to the system.

16. Using a digital multimeter, measure the sensor furnace voltage across pins 5 and 6 of terminal block TB1 in the Accessory Box (**NOT** on the FTC board). If the measured voltage is approximately 80 VAC, the new transformer is working properly.

17. Close the cover on the Accessory Box.

This completes the replacement of the transformer.

F.6 Replacing a Remote Transformer

In a remote FTC setup, the sensor furnace power transformer is located near the FTC board in the remote FTC Box. Its purpose is to convert the line voltage to the 80 VAC required for proper operation of the sensor furnace.

CAUTION! **To replace the transformer, the power to the FGA 300H(X) must be disconnected. Therefore, replace the transformer and reconnect the power as quickly as possible to prevent corrosion of the analyzer components due to acid condensation.**

The following items are needed to replace the transformer:

- A nutdriver (or similar tool)
- a digital multimeter

IMPORTANT: *This symbol indicates Caution - risk of electric shock.*

Refer to Figure 65 on page 149 and complete the following steps to replace the transformer:

1. Disconnect the main power to the FGA 300H(X).
2. Open the hinged cover on the standard (weatherproof) FTC box. For an explosion-proof (flameproof) FTC box, loosen the locking set screw on top of the FTC box and, using a long screwdriver across the slots provided, unscrew the cover from the enclosure.
3. Remove the four hex nuts and washers from the old transformer.
4. Move the old transformer aside (do not disconnect any wires yet) and place the new transformer into the remote FTC Box.
5. Disconnect the leads from the old transformer, one at a time, and connect the corresponding lead from the new transformer in its place, until all of the new leads have been connected.
6. Verify that the new transformer leads are properly connected by referring to Figure 68 on page 158.
7. Remove and discard the old transformer in accordance with local regulations.
8. Secure the new transformer in place with the four hex nuts and washers that were previously removed.
9. Reconnect the main power to the system.
10. Using a digital multimeter, measure the sensor furnace voltage across pins 5 and 6 of terminal block TB1 in the remote FTC Box (**NOT** on the FTC board). If the measured voltage is approximately 80 VAC, the new transformer is working properly.
11. Close/reinstall the cover on the remote FTC Box.

This completes the replacement of the transformer.

F.7 Adjusting the Sensor Furnace Temperature

In Chapter 4, *Calibration*, instructions are given for adjusting the operating temperature of the sensor furnace via a potentiometer on the FTC circuit board. For units fitted with the previous version of the FTC circuit board (1703-92), this potentiometer is designated as R28 and is located as shown in Figure 64 on page 147 or in Figure 65 on page 149. The calibration instructions are otherwise identical.

F.8 Previous Wiring Diagrams and Circuit Boards

The following drawings are included for reference to previous versions of the FGA 300H(X). They include:

- FTC Circuit Board layout
- Display Circuit Board layout
- Wiring Diagram with transformer
- Wiring Diagram without transformer

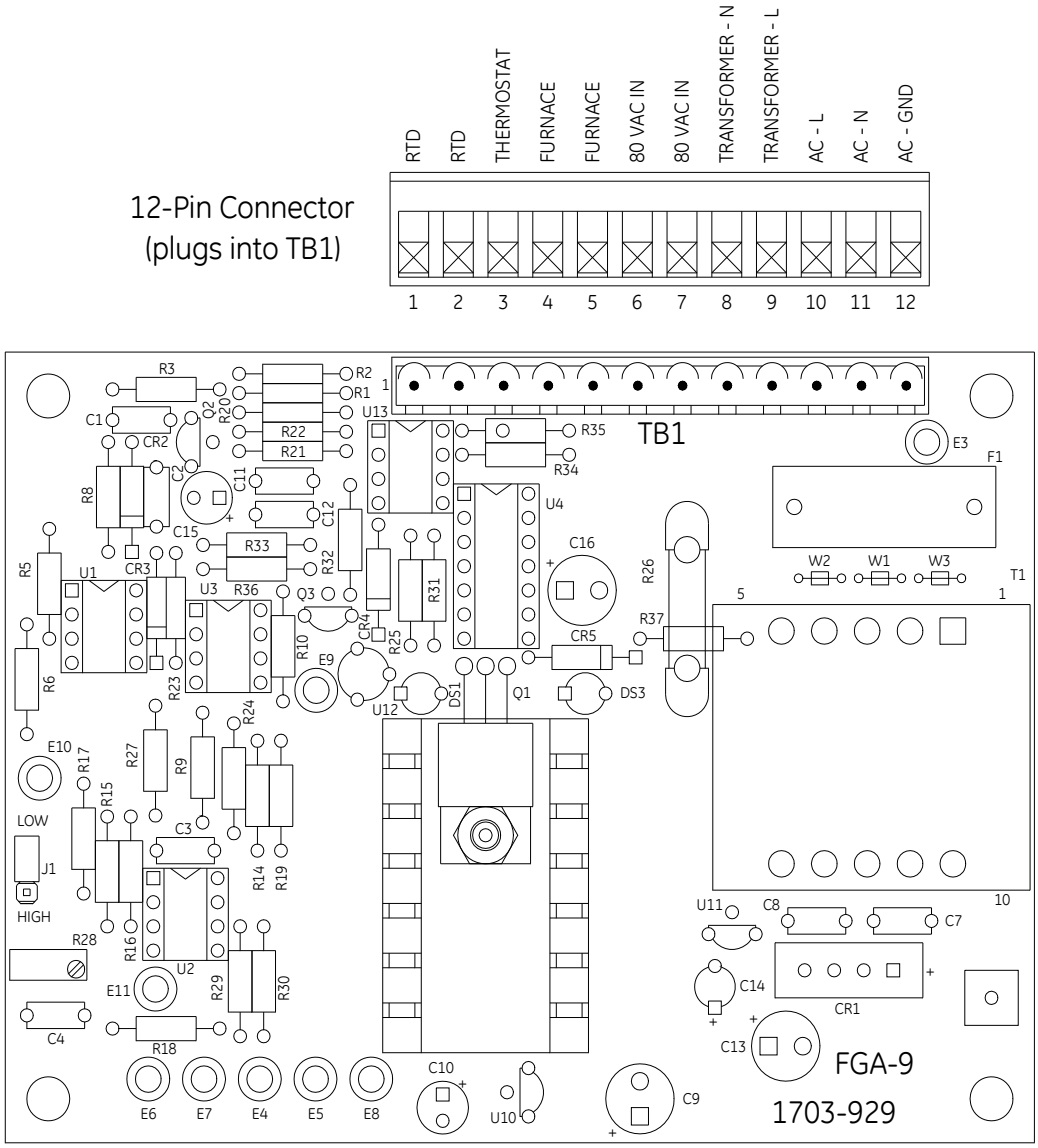


Figure 66: FTC Circuit Board - Previous (ref. dwg #1703-929)

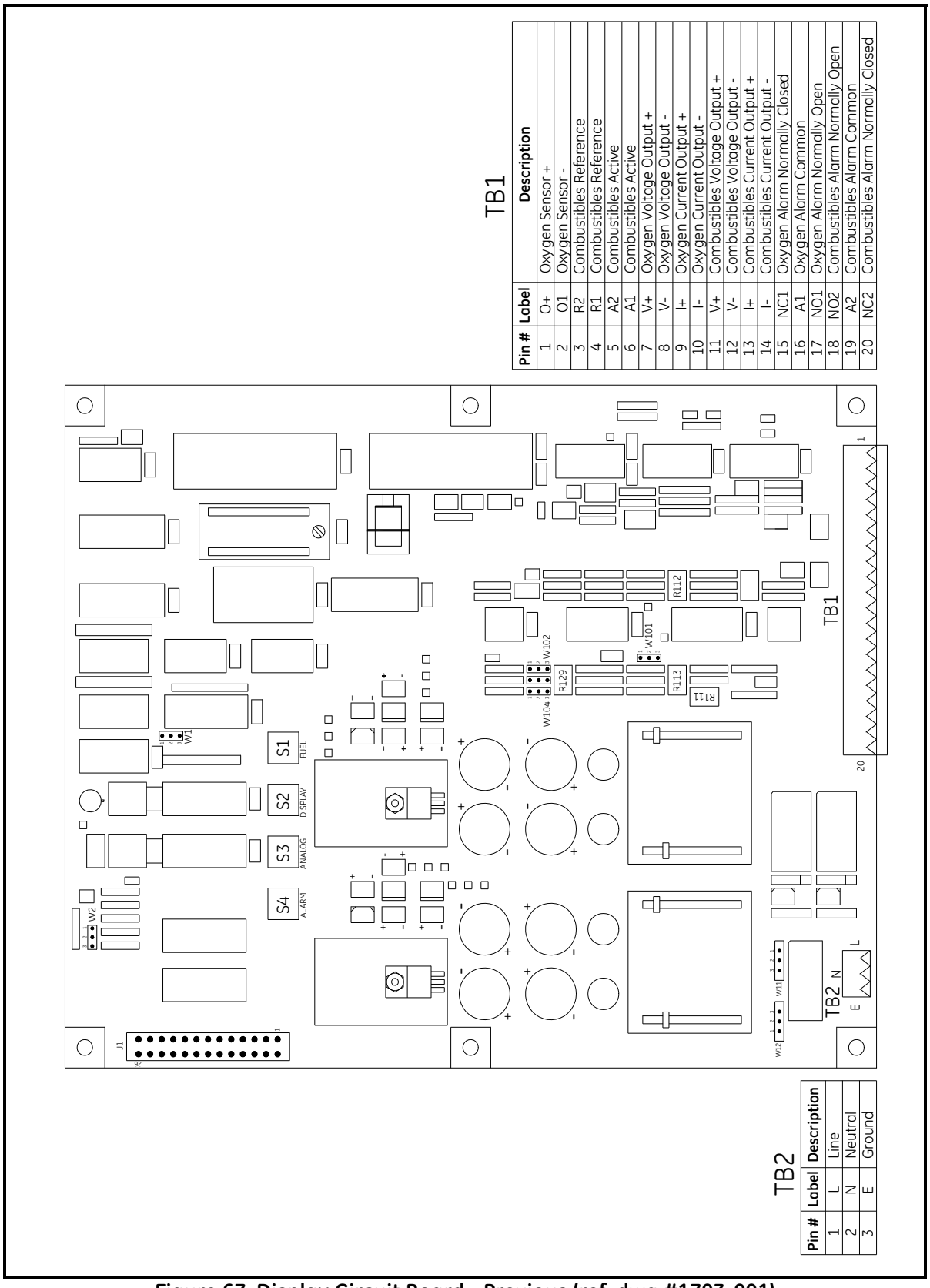

TB1
Pin # | Label | Description
1 | O+ | Oxygen Sensor +
2 | O1 | Oxygen Sensor -
3 | R2 | Combustibles Reference
4 | R1 | Combustibles Reference
5 | A2 | Combustibles Active
6 | A1 | Combustibles Active
7 | V+ | Oxygen Voltage Output +
8 | V- | Oxygen Voltage Output -
9 | I+ | Oxygen Current Output +
10 | I- | Oxygen Current Output -
11 | V+ | Combustibles Voltage Output +
12 | V- | Combustibles Voltage Output -
13 | I+ | Combustibles Current Output +
14 | I- | Combustibles Current Output -
15 | NC1 | Oxygen Alarm Normally Closed
16 | A1 | Oxygen Alarm Common
17 | NO1 | Oxygen Alarm Normally Open
18 | NO2 | Combustibles Alarm Normally Open
19 | A2 | Combustibles Alarm Common
20 | NC2 | Combustibles Alarm Normally Closed
TB2
Pin # | Label | Description
1 | L | Line
2 | N | Neutral
3 | E | Ground
S1 FUEL
S2 DISPLAY
S3 ANALOG
S4 ALARM
W1
W2
W101
W102
W104
W11
W12
R112
R129
R113
R111
J1
TB1
TB2
L
N
E

Figure 67: Display Circuit Board - Previous (ref. dwg #1703-001)

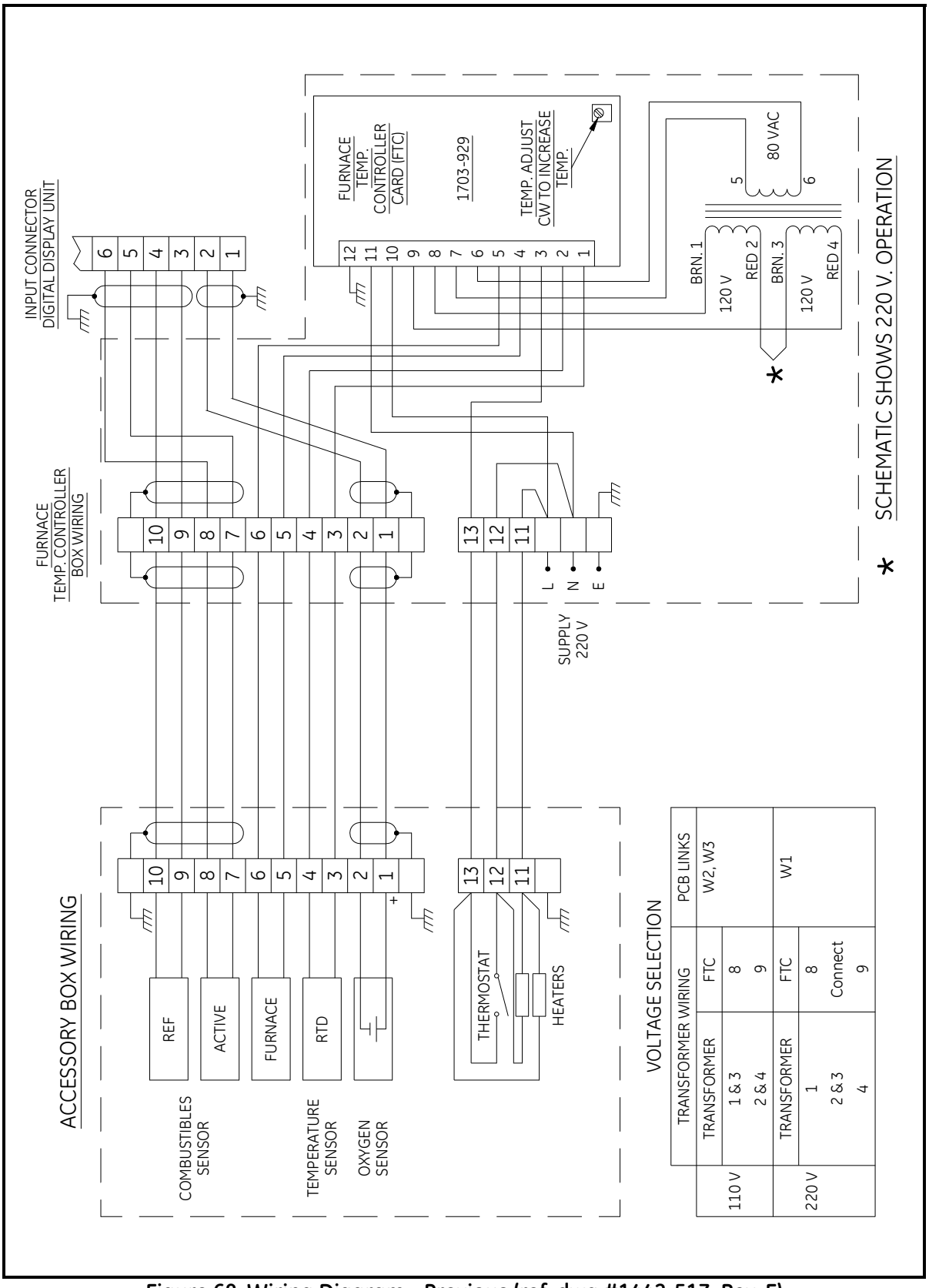


Figure 68: Wiring Diagram - Previous (ref. dwg #1442-517, Rev. E)

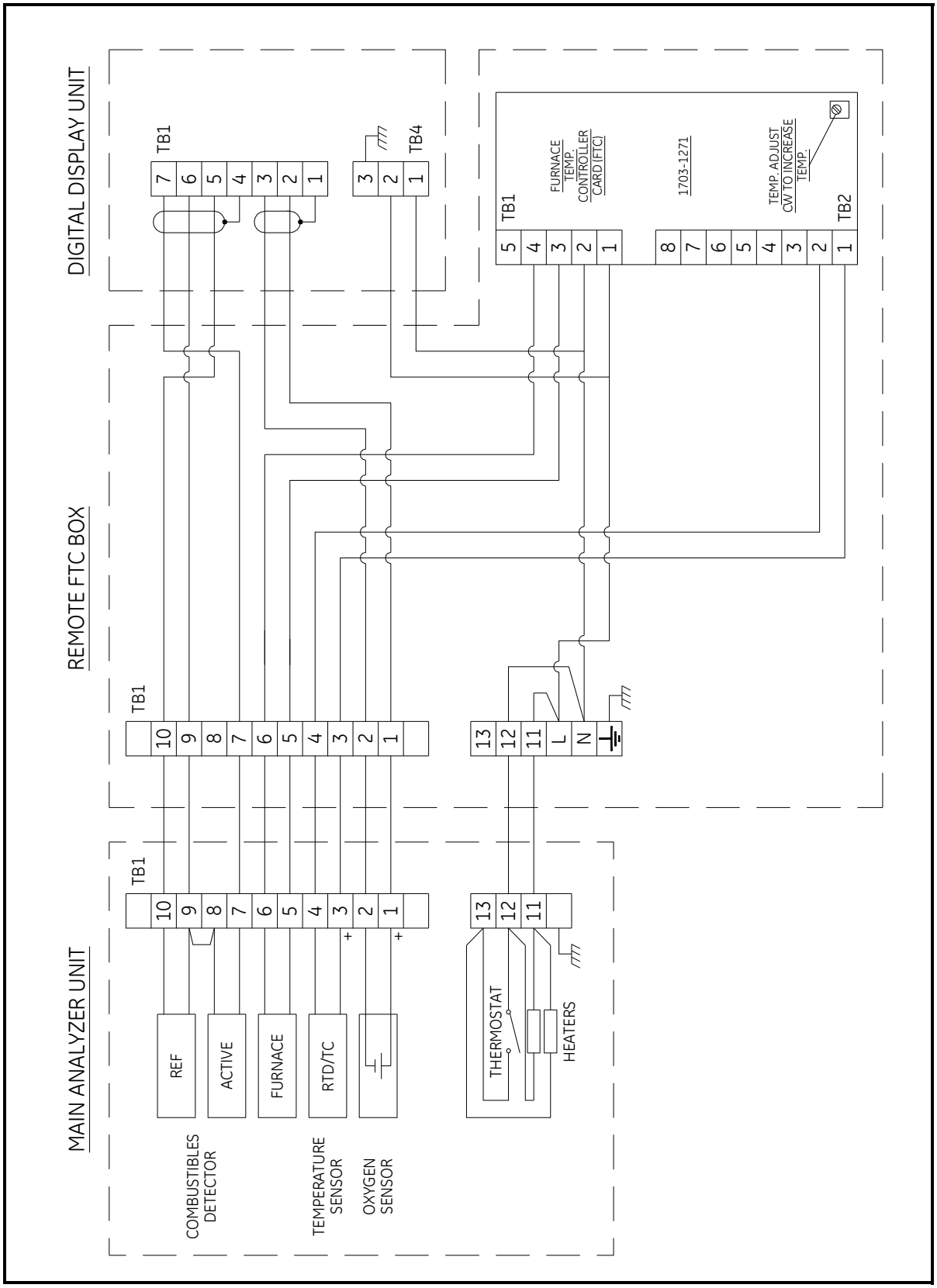


Figure 69: Wiring Diagram - Previous (ref. dwg #1442-517, Rev. F)

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A

Accessory Box 13
Alarms
  Selecting Combustibles Trigger Mode 36
  Selecting Oxygen Trigger Mode 36
  Setting Combustibles Trip Point 36
  Setting Oxygen Trip Point 34
  Wiring 33
Analog Output Range
  Adjusting Combustibles Channel 121
  Adjusting Oxygen Channel 119
  Recorders 33
Ancillary Components 37

B

Blowback System 65

C

Calibration
  Combustibles Detector 50
  Frequency 39
  Gas Flow Rate 45
  Oxygen Sensor 45
  Plumbing Connections 45
  Recommended Gases 43
Cartridge Heaters, Replacing 95
CE Mark Compliance 145
Combustibles Detector
  Calibration 50
  Description 1, 8
  Reference Element 71
  Replacing 84
  Span Check 52
  Wiring 86
  Zero Check 52
Common Problems 39
Connecting
  See Part Name
Convection Loop 6

D

Date of Publication i
Detector, Combustibles 1, 8
Disconnect Device 9, 20
Display
  Combustibles 41
  Oxygen 41
Display Electronics Console
  Description 5
  Testing 68
  Wiring 23, 30
Display Parameter Selection 118
Document Number i

E

EMC Compliance 145
Enclosures 1
Environmental Compliance iv
Error Indicators
  Combustibles 71
  Oxygen 55
  Table 54

F

FTC Board
  Replacing 101, 103, 151
  Testing 63, 148
FTC Box
  Ambient Temperature 23
  Description 4, 12
  Wiring 23, 28, 30
Fuel Type Selection 118
Furnace
  See Sensor Furnace
Fuse
  Display Board, Replacing 105
  FTC Board, Replacing 99, 102, 150

G

Gas Flow 14

H

Heaters, Replacing 95

I

Information Paragraphs iii

K

Keypad 41

L

LVD Compliance 9, 20, 145

M

Main Analyzer Unit
- Description 10
- Mounting 22
- Removing Cover 78
- Wiring 28

Measurements
- Displaying 41
- Taking 40

N

Nernst Equation
- Graphical Form 138
- Numeric Form 40, 137

O

Operating Principles 6
Options 111
Ordering Information 112
Oxygen Sensor
- Calibration 45
- Clips, Replacing 79
- Description 1, 6
- Replacing 81
- Testing 61
- Voltage Output 47

P

Plumbing Leaks 67
Power Input 30
Probe Assembly
- Description 14
- Installing 19

Purge Air 22

R

Recorders
- Analog Output Choices 33
- Wiring 33

Reference Air 22
Replacing
- See Part Name

Return Policy 165
RTD
- Replacing 87
- Testing 57

S

Safety
- Auxiliary Equipment iii
- General Issues iii
- Personal Equipment iii

Sample Gas Contamination 69
Sample System 2, 11
Sensor Furnace
- Adjusting Temperature 49, 155
- Checking Temperature 57
- Replacing 90
- Wiring 94

Sensor, Oxygen 1, 6
Shroud 14
Site
- Preparation 9, 20
- Selection 17

Spare Parts List 106, 107
Specifications
- Combustibles 110
- General 109
- Oxygen 110

Switches
- Display Electronics Console 23
- Selecting Display Parameter 117
- Selecting Fuel Type 117

T

Temperature
Heater Block 6
Sensor Furnace 6
Sensor Types 57
Thermocouple
Replacing 87
Testing 59
Thermostat, Replacing 97
Transformer
Replacing 154
Testing 148

V

Voltage, Line Input 16

W

Warm Up Time 39
Warranty 165
WEEE Directive iv
Wiring
See Part Name

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Warranty

Each instrument manufactured by GE Sensing is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE Sensing. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE Sensing determines that the equipment was defective, the warranty period is:

- one year from delivery for electronic or mechanical failures
- one year from delivery for sensor shelf life

If GE Sensing determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE Sensing, the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties or merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a GE Sensing instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE Sensing, giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE Sensing will issue a RETURN AUTHORIZATION NUMBER (RAN), and shipping instructions for the return of the instrument to a service center will be provided.
2. If GE Sensing instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.
3. Upon receipt, GE Sensing will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
- If GE Sensing determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner's approval to proceed, the instrument will be repaired and returned.

[no content intended for this page]

GE
Sensing

DECLARATION OF CONFORMITY

DOC-0035, Rev. A

We,

GE Sensing
1100 Technology Park Drive
Billerica, MA 01821
USA

declare under our sole responsibility that the

FGA300H and FGA300HX Horizontal Flue Gas Analyzers
FGA300V and FGA300VX Vertical Flue Gas Analyzers
FGA300D Display Unit
FGA311 In Situ Flue Gas Oxygen Analyzer

to which this declaration relates, are in conformity with the following standards:

- EN 61326-1: 2006, Class A, Table 2, Industrial Locations
- EN 61326-2-3: 2006
- EN 61010-1: 2001, Overvoltage Category II, Pollution Degree 2

following the provisions of the 2004/108/EC EMC and 2006/95/EC Low Voltage Directives.

The units listed above and any ancillary equipment supplied with them do not bear CE marking for the Pressure Equipment Directive, as they are supplied in accordance with Article 3, Section 3 (sound engineering practices and codes of good workmanship) of the Pressure Equipment Directive 97/23/EC for DN<25.

Billerica - August 2010
Issued

Mr. Gary Kozinski
Certification & Standards, Lead Engineer

CE

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